NPS-OR-11-001

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

Nett Warrior C3Conflict Experiment: Measuring the Effect of Battlefield Awareness in Small Units

by

Christian (Kip) Smith

January 2011

Approved for public release; distribution is unlimited

Prepared for: TRAC Monterey
Naval Postgraduate School
Monterey, CA 93943

THIS PAGE INTENTIONALLY LEFT BLANK

NAVAL POSTGRADUATE SCHOOL
MONTEREY, CA 93943-5001

Daniel T. Oliver
President

Leonard A. Ferrari
Executive Vice President and
Provost

This report was funded by and prepared for TRAC Monterey.

This report was prepared by:

CHRISTIAN (KIP) SMITH
Senior Lecturer of Operations Research

Reviewed by:

RONALD D. FRICKER
Associate Chairman for Research
Department of Operations Research

Released by:

ROBERT F. DELL
Chairman
Department of Operations Research

KARL VAN BIBBER
Vice President and
Dean of Research

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)* 01-2011	**2. REPORT TYPE** Technical Report	**3. DATES COVERED** *(From - To)*
4. TITLE AND SUBTITLE Nett Warrior C3Conflict Experiment: Measuring the Effect of Battlefield Awareness in Small Units	**5a. CONTRACT NUMBER**	
	5b. GRANT NUMBER	
	5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Christian (Kip) Smith	**5d. PROJECT NUMBER**	
	5e. TASK NUMBER	
	5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Operations Research Department Naval Postgraduate School Monterey, CA 93943-5219	**8. PERFORMING ORGANIZATION REPORT NUMBER** NPS-OR-11-001	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) TRAC Monterey Naval Postgraduate School Monterey, CA 93943	**10. SPONSOR/MONITOR'S ACRONYM(S)**	
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)	

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

14. ABSTRACT

This report discusses the findings of the Nett Warrior (NW) C3Conflict experiment and its implications for the NW Basis of Issue (BOI). The experiment used the C3Conflict war game to elicit and contrast measures of leader performance across two conditions that simulated alternative BOI for NW. C3Conflict is a distributed, computer-based, multiplayer, small unit war game designed to elicit measures of leader performance focusing on command, control, and communication. In the fully NW-enabled condition, the C3Conflict interface simulated the information and communication enabled by NW and made this package available to three soldiers—one in the role of Squad Leader (SL) and two in the role of Team Leader (TL). In contrast, in the partially NW-enabled condition, C3Conflict made that package available only to SL; the interface for the two TL simulated the limitations of line-of-sight vision. Eighteen hypotheses were tested. All predicted that unit performance would be better in the fully NW-enabled condition. Ten were confirmed. No measures showed superiority for the partially NW-enabled condition. These findings support the argument that the fully NW-enabled BOI improves squad-level communications, coordination, and maneuvers. In the discussion section, these results are interpreted to reveal that the fully-enabled BOI is the preferable option for two reasons. First, if SLs use the full range of capabilities offered by NW, their workload is likely to decrease. Second, the fully-enabled BOI promotes the autonomy and battlefield awareness of TLs. Fully-enabled TLs are likely to be better prepared to assume command, if necessary.

15. SUBJECT TERMS
Nett Warrior, small unit command and control, battlefield awareness, C3Conflict mircoworld

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
			UU	91	
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified			

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

This report discusses the findings of the Nett Warrior (NW) C3Conflict experiment and its implications for the NW Basis of Issue (BOI). The experiment used the C3Conflict war game to elicit and contrast measures of leader performance across two conditions that simulated alternative BOI for NW. C3Conflict is a distributed, computer-based, multiplayer, small unit war game designed to elicit measures of leader performance focusing on command, control, and communication. In the fully NW-enabled condition, the C3Conflict interface simulated the information and communication enabled by NW and made this package available to three soldiers—one in the role of Squad Leader (SL) and two in the role of Team Leader (TL). In contrast, in the partially NW-enabled condition, C3Conflict made that package available only to SL; the interface for the two TL simulated the limitations of line-of-sight vision. Eighteen hypotheses were tested. All predicted that unit performance would be better in the fully NW-enabled condition. Ten were confirmed. No measures showed superiority for the partially NW-enabled condition. These findings support the argument that the fully NW-enabled BOI improves squad-level communications, coordination, and maneuvers. In the discussion section, these results are interpreted to reveal that the fully-enabled BOI is the preferable option for two reasons. First, if SLs use the full range of capabilities offered by NW, their workload is likely to decrease. Second, the fully-enabled BOI promotes the autonomy and battlefield awareness of TLs. Fully-enabled TLs are likely to be better prepared to assume command, if necessary.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I. INTRODUCTION....1
A. BACKGROUND....1

II. THE RESEARCH ISSUE....3

III. HYPOTHESES....5
A. COORDINATED UNIT NAVIGATION....5
B. EMPLACEMENT AND ADJUSTMENT OF TACTICAL POSITIONS....6
C. CONDUCT PRECISE OPERATIONS....6
D. REINFORCEMENT OF AN ENGAGED UNIT....6
E. CLEARANCE OF INDIRECT FIRE....7
F. COMMUNICATION DURING MOVEMENT....7
G. AUTONOMOUS/DECENTRALIZED MOVEMENT....7
H. LEADER'S INTENT REMOTELY TRANSLATED....8
I. MARKING ENEMY POSITIONS ON THE COMMON OPERATING PICTURE....8

IV. METHOD....9
A. PARTICIPANTS....9
B. PLATFORM....9
C. EXPERIMENTAL CONDITIONS....11
D. PROCEDURE....13
1. Informed Consent and Demographic Questionnaire....13
2. Training Scenario....14
3. Tactical Brief....14
4. Experimental Scenarios....15
E. MEASURES....16
1. Position as a Function of Time....16
2. Commands....16
3. Chat-Based Communications....16
F. PROTOCOL ANALYSIS....16

V. RESULTS....21
A. COORDINATED UNIT NAVIGATION....22
B. EMPLACEMENT AND ADJUSTMENT OF TACTICAL POSITIONS....24
C. CONDUCT PRECISE OPERATIONS....25
D. REINFORCEMENT OF AN ENGAGED UNIT....27
E. COMMUNICATION DURING MOVEMENT....27
F. AUTONOMOUS/DECENTRALIZED MOVEMENT....30
G. LEADER'S INTENT REMOTELY TRANSLATED....32
H. MARKING ENEMY POSITIONS ON THE COMMON OPERATING PICTURE....33

VI. DISCUSSION 35
A. THE FULLY NW-ENABLED BOI IMPROVES THE FLOW OF INFORMATION UP AND DOWN THE CHAIN OF COMMAND 35
B. MOVEMENT 35
C. THE FULLY NW-ENABLED BOI DECREASES SL WORKLOAD 36
D. THE FULLY NW-ENABLED BOI INCREASES TL AUTONOMY, EMPOWERMENT, AND RESPONSIBILITY 36
E. LIMITATIONS OF THE C3CONFLICT EXPERIMENTAL PLATFORM 37
1. Unit Navigation 37
2. Distortion of Distances 37
3. Common Operational Picture (COP) 37
4. Command and Control (C2) 38
APPENDIX 1. WELCOME 39
APPENDIX 2. INFORMED CONSENT FORM 41
APPENDIX 3. DEMOGRAPHIC QUESTIONNAIRE 43
APPENDIX 4. TRAINING SCRIPT 45
APPENDIX 5. TACTICAL BRIEF 55
APPENDIX 6. SCRIPT FOR MISSION 1 (BLUE SQUAD) – ASSAULT ON SAFE HOUSE 59
APPENDIX 7. SCRIPT FOR MISSION 2 (RED SQUAD) – CORDON AND ADJUST TACTICAL POSITION 63
APPENDIX 8. SCRIPT FOR MISSION 3 (WHITE SQUAD) – CORDON AND REINFORCE ENGAGED UNIT 69
LIST OF REFERENCES 73
INITIAL DISTRIBUTION LIST 75

LIST OF FIGURES

Figure 1. Aerial photo covering the area of operations during the experiment annotated with C3Conflict gridlines. 10
Figure 2. Screen-capture of the C3Conflict interface for TL Alpha in a fully NW-enabled mission. 11
Figure 3. Screen-capture of the C3Conflict interface for TL Alpha in a partially NW-enabled mission. 12
Figure 4. Aerial photo with annotations showing the three components of the search and cordon mission. The red triangle marks the operational objective. ...15
Figure 5. Graph showing the average number of directives to huddle 23
Figure 6. Graph showing the average number of commands to change course during a maneuver. 23
Figure 7. Graph showing the average time in seconds to reach, establish, and announce set at the initial cordon position. 24
Figure 8. Graph showing the average separation between the lines taken by TLs and the line taken by their SL. The unit of measurement is a C3Conflict cell, a square nominally five meters on a side. 26
Figure 9. Graph showing the maximum separation between the lines taken by TLs and the line taken by their SL. The unit of measurement is a C3Conflict cell, a square nominally five meters on a side. 26
Figure 10. Graph showing the distribution of the total counts of chat communications from the SL to the PL in the 30 missions 27
Figure 11. Graph showing the distribution of the total counts of chat communications from the SL to TLs in the 30 missions. 28
Figure 12. Graph showing the number of directives that specified moving in a cardinal or relative direction or that specified following the SL or chemlight trail. 29
Figure 13. Four examples of chemlight use by SLs in the fully NW-enabled condition. (a) An assault on the objective. (b) Approaching the northwest cordon position. (c) Adjusting that position. (d) Approaching the northeast cordon position. 30
Figure 14. Graph showing the average number of C3Conflict cells that TLs moved their units on the map. 31
Figure 15. Graph showing the average time in seconds for a SL to transmit or translate or both a FRAGO from the PL to the TL. 32

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

Table 1. Demographic characteristics of the soldiers who participated in the experiment.....9
Table 2. Velocity of travel as a function of terrain. 11
Table 3. Top-level categories used to score the protocol of the soldiers' text-based "chat" communications. 17
Table 4. Subcategories for Pulls, Pushes, and Scripts used to score the protocol of the soldier's chat. 18
Table 5. Subcategories for Directives used to score the protocol of the soldier's chat. 18
Table 6, part 1. Hypotheses and results of statistical tests. All hypotheses are one-sided, Full < Partial, unless otherwise noted.....21
Table 6, part 2. Hypotheses and results of statistical tests. All hypotheses are one-sided, Full < Partial, unless otherwise noted.....22

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGEMENTS

This research was supported by a grant from TRAC Monterey. MAJ Paul Evangelista, USA, was the project monitor. He provided the background and inspiration for the specification of hypotheses and the design of the experiment. COL James Riley, USA (Ret.) of Augustine Consulting, Inc., was the subject matter expert. He scripted the experimental scenarios, played an instrumental role in the conduct of the experiment at Fort Benning, and drafted the section on the limitations of the experimental platform. We thank the leaders and soldiers of the EXFOR for making themselves available for the study. Dr. Rego Granlund of Rationella Datortjänster modified C3Conflict so that it could emulate an information-starved environment in the partially NW-enabled condition and chemlights in the fully NW-enabled condition.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

A. BACKGROUND

The Nett Warrior (NW) system is emergent wireless technology designed to enhance battlefield awareness. This experiment focused on determining the benefit of one of several NW system capabilities—a near-real time common operational picture (COP) that includes friendly position and operational graphics. A soldier enabled by this common sense of position and purpose is likely to feel empowered, relevant, and important.

Previous analyses have found that NW can have three beneficial impacts on the capability of leaders of dismounted soldiers: (1) it can enhance navigation; (2) it can provide a shared operational picture; and (3) it can alter and improve modes of command and control (C2). These capability enhancements are discussed in turn.

To enhance dismounted navigation, NW provides the leader with self-scaling, high-resolution maps or digital imagery. Superimposed on that map or image is an icon that represents his GPS-based location and orientation. The system also allows the leader to compare his current icon location with geo-referenced way points (digital "chemlights") and other graphic control measures. The leader can place chemlights on the display for a variety of purposes including, but not limited to, laying a track for soldiers to follow and marking enemy positions. The helmet-mounted display provides easy access to the map for continuous or quick nonobtrusive location tracking during movements.

Up-to-date operational graphics and symbols of both friendly and enemy forces remain the cornerstone of the COP and effective C2. To provide a COP, NW provides access during all phases of an operation to large quantities of preloaded, self-scaling, geo-referenced digital maps and imagery files that are annotated with operational graphics and symbols. The leader can quickly zoom (in or out) from a regional view (e.g., a 1:250,000 resolution map or aerial photo) to 1-meter or even submeter-level imagery for maximum clarity and detail at the decisive point during an operation.

NW supports the continuous updating of graphics and symbols across the tactical communications network. It is able to display an individual icon for every NW-enabled leader within a designated organization. This enhanced visibility of subordinate and adjacent units that are often beyond the line of sight, which may be set in position or maneuvering, in real time, is a powerful mitigation against fratricide. Leaders are better able to direct and control the application of lethal assets in relation to friendly forces. To prevent cluttering the display with detail and unwanted information, NW provides a filtering capability that each individual leader can use to scale and tailor his display to fit his assessment of his current C2 needs.

To enhance C2, NW provides the digital "chemlight," a simple and highly adaptable method for describing and directing action. The leader can use chemlights to coordinate the efforts of his NW-enabled subordinates in order to coordinate unit navigation, to conduct precise operations, or to focus combat power. The leader can also use chemlights to post significant information on the digital display such as the locations

of potential threats, of cleared or friendly occupied structures, of the initial location of enemy contact, of intended movement routes, and of other features on the battlefield. When combined with voice or radio transmission of directives, digital chemlights can provide additional clarity and augment soldier understanding. This capability all but eliminates the need for the "leader huddle" that has historically been used to gather leaders at a central location to explain and diagram the tactical plan for subordinates.

II. THE RESEARCH ISSUE

The Army is committed to fielding NW, but has yet to resolve its Basis of Issue (BOI). This study investigates two BOIs. The partial BOI provides NW to Squad Leaders (SLs), but not to their subordinate Team Leaders (TLs). The more inclusive full BOI is to provide NW to TLs as well. A third option (that is not studied here) is the legacy system, in which SLs and TLs rely on paper maps, information from the Global Position System (GPS), and radio communications to estimate the locations of friendly forces.

Training and Doctrine Command (TRADOC) Analysis Center (TRAC) Monterey has been assigned the responsibility of evaluating the potential benefits of NW and of assessing the alternative BOI. This task involves gathering empirical evidence that documents the potential benefits to be realized by adopting the alternative BOI for distributing NW to rifle squads.

The research question addressed here is whether rifle squad effectiveness is likely to be influenced by the availability and distribution of NW within a squad. Specifically, it contrasts the exercise of C2 by squads that are partially NW-enabled (only SLs have been issued NW) and by squads that are fully NW-enabled (SLs and TLs have been issued NW). This study does not include any analysis of the cost or logistic burden of the alternative BOI.

THIS PAGE INTENTIONALLY LEFT BLANK

III. HYPOTHESES

To inform the BOI decision, we built upon previous work to develop hypotheses that predicted when, where, and how the fully-enabled BOI would be likely to improve squad performance. In August 2009, MAJ Paul F. Evangelista, USA, of TRAC Monterey, presented an analysis of the advantages provided by NW (Evangelista, 2009). The brief identified nine emergent behaviors that are likely to be beneficially affected by deployment of NW.

- Coordinated unit navigation
- Emplacement and adjustment of tactical positions
- Conduct precise operations
- Reinforcement of an engaged unit
- Clearance of indirect fire
- Autonomous/decentralized movement
- Leader's recon remotely translated (chemlights and updated graphics)
- Communication during movement (chemlights and text messages)
- Marking of enemy positions on a COP

This list guided the specification of hypotheses to be tested, the specification of measures to test those hypotheses, and the design of the experiment. This section motivates and describes the 18 hypotheses that emerged from this analysis.

Constraints on the conduct of the experiment also guided the specification of hypotheses. The primary constraint was the focus on rifle squads and on squad-level (rather than platoon- or brigade-level) performance. Other constraints were the limited availability of active duty soldiers who could serve as participants, the modest budget, and the strengths and weaknesses of the C3Conflict experimental platform.

A. COORDINATED UNIT NAVIGATION

The first emergent behavior, coordinated unit navigation, concerns the leader's ability to control the movement of multiple units across the battlefield in a decentralized and synchronized manner. As the SL was the only leader to participate in the study, coordination was restricted to the synchronization of movement by the two TLs and of his own. The experiment tested three hypotheses relevant to the impact of the alternative BOI on the SL's attempts to control the movement of his squad. We expected the SL in the fully NW-enabled condition to (1) call for fewer huddles (in-field briefs), (2) issue fewer commands to steer the squad, and (3) issue fewer commands of all kinds. Here and elsewhere in this report we use the letter N to represent the observed count (a number) of the event of interest.

- N huddles (at dismount and during mission) full < partial
- N commands to change course during maneuver full < partial
- N commands of all kinds during maneuver full < partial

B. EMPLACEMENT AND ADJUSTMENT OF TACTICAL POSITIONS

The second emergent behavior concerns the exercise of C2 required to emplace the squad at its intended location. Control takes time and effort. We expected squads in the fully NW-enabled condition to take less time to move out and to reach the intended location when moving from a dismount location to a cordon position and when adjusting position following receipt of a fragmentary order (FRAGO). Further, we expected SLs to issue fewer commands to fine-tune the squad's position:

- Time to move out following FRAGO to adjust position full < partial
- Time to reach cordon position full < partial
- N commands to correct positioning full < partial

C. CONDUCT PRECISE OPERATIONS

This emergent behavior concerns the quality of executing a scheme of maneuver, especially in time-sensitive missions. The precision of movement can be seen as the outcome of the leader's attempts to coordinate unit navigation. The experiment tested three hypotheses relevant to the impact of the alternative BOI on the outcomes of the SL's attempts to control the movement of his squad. Two of the hypotheses spring from the prediction that NW-enabled TLs will adhere more closely to the line specified and followed by the SL. If this holds, then both the average and maximum separation of the lines taken by the TLs from the line taken by their SL will be less in the fully NW-enabled condition. Finally, we expected the extra distance traveled by TLs when compared to the line taken by their SL to be smaller in the fully NW-enabled condition.

- Average separation of TL lines from SL line full < partial
- Maximum separation of TL lines for SL line full < partial
- Extra distance traveled full < partial

D. REINFORCEMENT OF AN ENGAGED UNIT

This emergent behavior concerns the actions taken by a unit that seeks to reinforce a unit that is taking live fire. These actions include selecting the direction of approach (from behind, from the side) and taking high ground. The goals of these actions are to reduce the likelihood of fratricide, while speeding an effective reinforcement. Because C3Conflict does not emulate live fire well, it was not possible to test hypotheses about the likelihood of fratricide. It was, however, possible to test two hypotheses about the speed with which a squad reinforces a unit taking direct fire. We expected squads in

the fully NW-enabled condition to be quicker both to respond to the order to reinforce another squad and to reach a position where they could engage the enemy:

- Elapsed time to move out following FRAGO to reinforce full < partial
- Elapsed time to reach position full < partial

E. CLEARANCE OF INDIRECT FIRE

The fifth emergent behavior concerns the minimization or elimination of fratricide during artillery bombardment. The experiment focused on C2 in rifle squads and did not address this topic.

F. COMMUNICATION DURING MOVEMENT

The sixth emergent behavior concerns the content of the messages used by the SL to coordinate the squad's navigation. The focus here is on what is said in the exercise of C2. In the fully NW-enabled condition, but not in the partially NW-enabled condition, the SL can use the digital chemlights to specify the path to be followed. Further, the presence of a chemlight trail on the enhanced digital map should reduce the need for verbal directives that instruct TLs to move in a cardinal (e.g., north) or relative (e.g., to the left) direction. The experiment tested both of these hypotheses:

- Directives to follow a track designated by chemlights full > 0
- Directives using cardinal or relative directions full < partial

Related hypotheses concerning the number and types of commands issued by the SL were introduced in the context of the first emergent behavior, coordinated unit navigation. Even though they pertain directly to the impact of the alternative BOI on SL communication, they are not repeated here.

G. AUTONOMOUS/DECENTRALIZED MOVEMENT

This emergent behavior describes changes in the mindset and actions of soldiers when they become equipped with NW. NW provides soldiers with a COP that shows where they and other members of their squad and platoon are. The digital chemlights enable nonverbal communication of leader intent for a variety of purposes. A soldier enabled by this common sense of position and purpose is likely to feel empowered, relevant, and important. Obtaining data on this mindset is beyond the scope of this experiment. However, three behavioral manifestations of this mindset should be evident in the conduct of the C3Conflict missions. The first is the size of individual movements before pausing to regroup or reassess. We expected this move distance to be greater in the fully NW-enabled condition. The second is the dispersion during movement. Dispersion refers to the separation of squad members. We expected both the average and maximum separation to be greater when TLs were provided with NW (in the fully NW-enabled condition).

- Average distance moved in one step full > partial
- Average dispersion of the three units while moving full > partial

H. LEADER'S INTENT REMOTELY TRANSLATED

The eighth emergent behavior concerns how and how quickly the SL is able to translate the platoon leader's intent into directives that the TLs follow. This translation involves turning the directives contained in a FRAGO into specifications of routes, positions, and responsibilities. The experiment was designed to test two hypotheses related to the translation of leader intent. Given the ability of NW to support a COP, we expected SL in the fully NW-enabled condition to make the TLs aware of any change in mission more quickly. We also expected the SL in the fully NW-enabled condition to take advantage of the chemlights to specify routes and positions following a FRAGO:

- Elapsed time to transmit leader intent following FRAGO full < partial
- Use of chemlights to mark tactical positions full > 0

I. MARKING ENEMY POSITIONS ON THE COMMON OPERATING PICTURE

The final emergent behavior concerns the use of chemlights to mark enemy positions. In the fully NW-enabled condition, the TLs have this ability. In the partially NW-enabled condition, they do not. Accordingly, we expected squads in the fully NW-enabled condition to make more use of chemlights to communicate information about the enemy:

- Use of chemlights to mark enemy positions full > partial

IV. METHOD

To test these hypotheses, this experiment used a computer-based, small unit war game to examine the effect of NW-like information on the performance of a single rifle squad consisting of one SL and two TLs. The squad's task was to conduct a series of three cordon and assault missions aimed at neutralizing an improvised explosive device (IED) cell leader in Taji, Iraq.

A. PARTICIPANTS

All 30 participants had leadership experience at the team level or higher and were assigned to the Experimental Force (EXFOR) at Fort Benning, Georgia. All but one of the soldiers had returned from tours in Iraq or Afghanistan or both. Table 1 summarizes their self-report demographic data across experimental conditions (fully- or partially-NW enabled). Inspection of Table 1 supports the inference that the participants are representative of the population to which the experiment seeks to generalize. Further, there appears to have been no systematic bias across experimental conditions.

Table 1. Demographic characteristics of the soldiers who participated in the experiment.

Age and Service			**Tours in Iraq/Afghanistan**		
Age (yrs)	Full	Partial	N Tours	N Participants	
Mean	26.9	26.9		Full	Partial
Max	41	36	0	1	1
Min	21	21	1	8	5
			2	6	4
Yrs Service	Full	Partial	3	0	4
Mean	6.2	6.3	4	0	0
Max	16	12	5	0	0
Min	2	3	6	0	1
	N Participants			N Months	
Rank	Full	Partial		Full	Partial
SFC	1	1	Mean	17	24
SSG	4	2	Max	27	55
SGT	5	6	Min	0	0
SPC	5	6			

B. PLATFORM

The C3Conflict experimental platform was used to simulate the information and communications supported by the NW system. C3Conflict is a "microworld"—a distributed, computer-based simulated environment that realistically captures much of the complex, opaque, and dynamic nature of real-world problems (Brehmer, 2005; Brehmer

& Dörner, 1993; Granlund, 2003). C3Conflict is an update of the C3Fire platform that has been used in the Human System Integration Laboratory (HSIL) at the Naval Postgraduate School (NPS) for several years (Colebank, 2008; Hernandez, Ray, Papadapoulas, & Glaser, 2010; Thomas, 2005). C3Fire has been used extensively in research on distributed decision making and networked-based C2 (Johansson, Persson, Granlund, & Mattsson, 2003; Rigas, Carling, & Brehmer, 2002). Doctor Smith, the principal investigator in this project and author of this report, has extensive experience conducting experiments using the C3Conflict suite of microworlds (Lindgren & Smith, 2006a, 2006b; Lindgren, Smith, & Granlund, 2007; Smith, 2008; Smith, Lindgren, & Granlund, 2006, 2010).

For this experiment, C3Conflict presented participants with an aerial image of the area of operations—the village of Taji, Iraq and the surrounding date groves (Figure 1). A grid of cells divided the image into square cells five meters on a side. The 50-meter gridlines shown in Figure 1 contain 100 (10x10) cells. During the experiment, an icon on the image indicated the participant's location. Other icons indicated the locations of other participants and, when visible, hostile forces. By pointing-and-clicking, participants were able to move their icons on the image. As shown in Table 2, the rate of movement depended upon the terrain. Movement down the main road was faster than in the alleys between buildings and in the date groves. Movement was slow inside a building. The velocities were chosen to emulate the actual rates of movement by dismounted infantry.

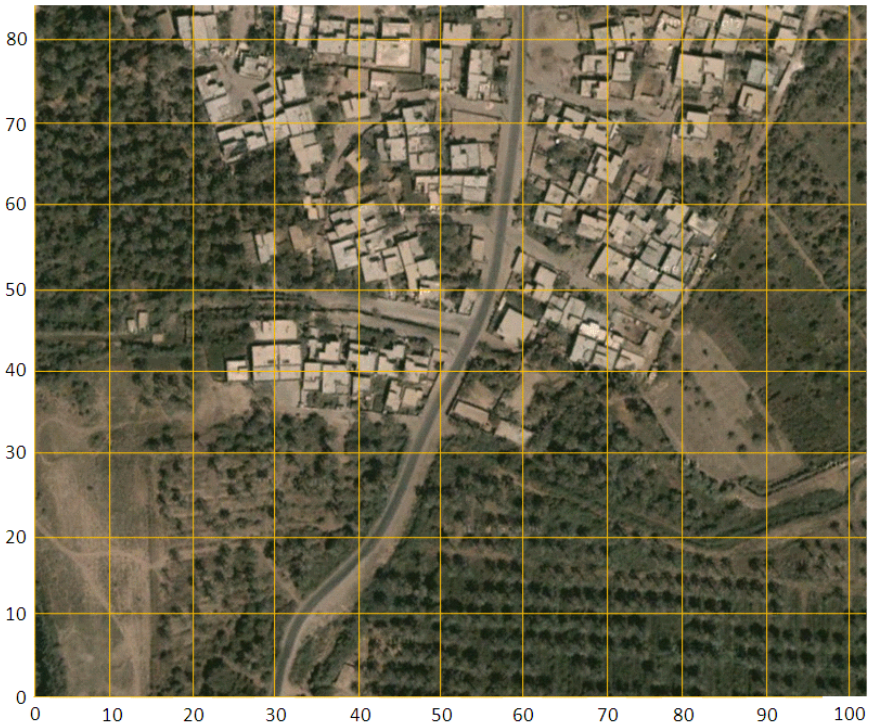

Figure 1. Aerial photo covering the area of operations during the experiment annotated with C3Conflict gridlines.

Table 2. Velocity of travel as a function of terrain.

Terrain	Sec per Cell	kph
Within buildings	45	0.40
In groves	12	1.50
Between buildings	3	6.00
On the main road	2	9.00

C. EXPERIMENTAL CONDITIONS

There were two experimental conditions. One simulated the fully NW-enabled BOI and the other the partially NW-enabled BOI. The contrast can be seen by comparing Figures 2 and 3. Figure 2 is a screen-capture of the C3Conflict interface seen by Alpha Team during a fully NW-enabled mission (second mission - northwest cordon, Tuesday morning, file 44). In this mission, the squad is represented by three red icons. The squad has just arrived at its objective and established the northwest cordon. Figure 3 is the corresponding screen-capture (the interface seen by Alpha Team at its cordon position) during a partially NW-enabled condition (second mission, Tuesday afternoon, file 50). There are two differences across the experimental conditions, the scope of the map and the ability to see and deploy digital chemlights. These are discussed in turn.

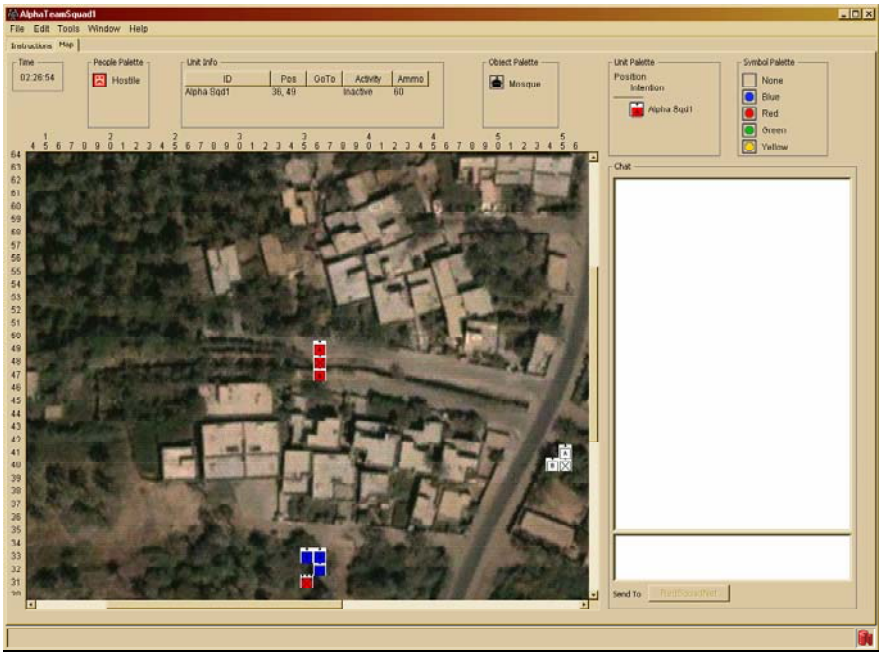

Figure 2. Screen-capture of the C3Conflict interface for TL Alpha in a fully NW-enabled mission.

In the fully NW-enabled "Team Leader BOI," C3Conflict presented all three soldiers—the SL and the two TLs—with the interface shown in Figure 2. The interface contains 200m x 200m of an aerial photo of the area surrounding the objective. Grid

coordinates appear above and on the left side of the image. In the fully NW-enabled condition, the entire map can be explored by moving the horizontal and vertical scrollbars. The icons on the image represent the locations of (1) the soldier—the red icon with the letter A for Alpha Team, (2) the two other members of the squad—the red icon with the X for the SL and the red icon with the letter B for Bravo Team, (3) other squads in the platoon—white and blue icons, and (4) the platoon leader—the red icon with the X and three dots. In sum, in the fully NW-enabled condition, all three members of the squad had complete and accurate information about the locations of all participants in the mission.

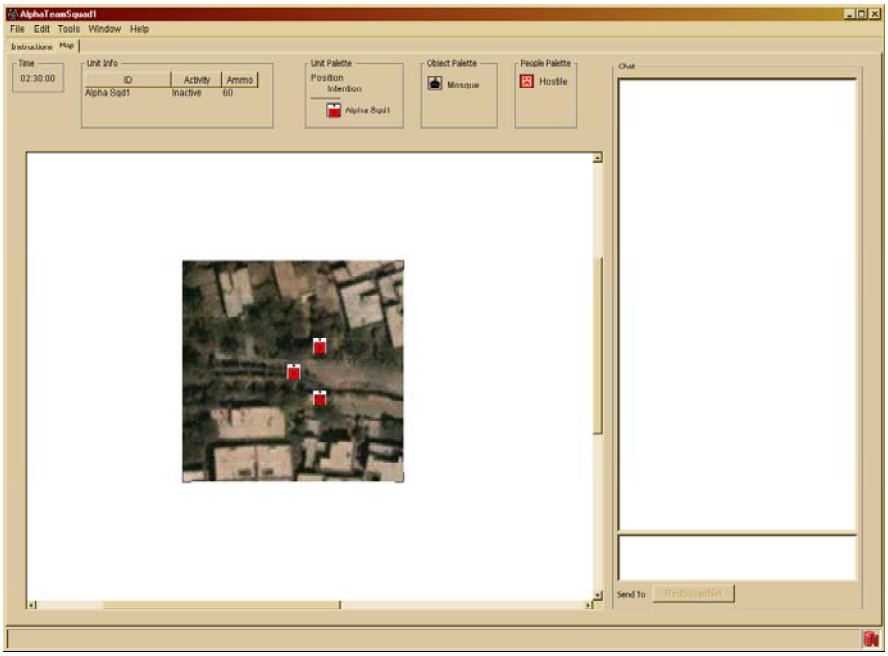

Figure 3. Screen-capture of the C3Conflict interface for TL Alpha in a partially NW-enabled mission.

In contrast, in the partially NW-enabled "Squad Leader BOI," the interface for the two TLs simulated the limitations of line-of-sight vision. A typical example is shown in Figure 3. The image area is largely white. A small zone within the image area (100m x 100m) offers a window to the aerial image. The visible zone is centered on the soldier's position and represents the soldier's limited visual range. Using the scrollbars does not reveal more of the image. There are no grid coordinates around the image. Icons on the image represent the locations of soldiers who are within this restricted field of view. Those who are out of sight are not shown. Hence, in the partially NW-enabled condition, a TL had accurate information about the locations of only those soldiers whom he could be expected to see.

In both conditions, the SL used an interface like that shown in Figure 2.

The second difference across experimental conditions was the capacity of soldiers in the fully NW-enabled condition to embed and view digital chemlights on the aerial photo. C3Conflict represents digital chemlights with colored dots that fit within a single

cell on the image. To place a chemlight on the image, a soldier in the fully NW-enabled condition, Figure 2, had to click on one of the dots in the Symbol Palette located in the top right corner of the interface and then click on the desired cell on the image. C3Conflict would then "paint" a chemlight on the image. As shown in Figure 3, TL in the partially NW-enabled condition had no access to the symbol palette. Nor could they see a chemlight painted on the image by their SL (who had the fully NW-enabled screen). In the fully NW-enabled condition, SL and TLs could communicate using digital chemlights. In the partially NW-enabled condition, they could not.

The white panels on the right sides of Figures 2 and 3 are the chat windows. This emulation of radio communications was identical across the two experimental conditions. The upper window displayed received messages. The soldiers used the lower window to type messages. They used the "Send" button below the chat windows to transmit a message they had typed. As shown in Figures 2 and 3, TLs had access to only one Send button (i.e., access to one radio frequency). This button sent messages to the "Squad net." Members of the Squad net were the SL and the two TLs. In contrast, the SL had access to two Send buttons and two nets—the Squad net and the Platoon net (e.g., two radio frequencies). Members of the Platoon net were the SL and the experimenter who played the role of Platoon Leader (PL). SL saw messages from both nets in the same window. TLs had no access to the Platoon net.

In both conditions, squad members were instructed not to speak and to limit all communication to typed messages in the chat window.

D. PROCEDURE

The experiment was conducted in a classroom on the second floor of the McKenna Military Operations in Urban Terrain (MOUT) Site at Fort Benning, Georgia. Two experimental sessions were conducted each day for five days, one in the morning and one in the afternoon. Each session lasted approximately three hours. No problems with participation or the computer network were encountered. The study ran smoothly every day.

Soldiers reported in groups of three. The senior member assumed the role of SL. The other two soldiers assumed the roles of TLs reporting to the SL. One three-man "squad" participated in each session for a total of 10 squads and 30 soldiers.

After introductions had been made, the soldiers sat at their assigned workstations. Tables were arranged in a "U" with chairs on the outside. The experimenters sat at three workstations at the bottom of the U. The SL sat at a workstation on the right side of the U. The two TLs sat at workstations on the left side of the U. All participants could make eye contact, but were instructed not to talk during the experimental sessions. The SL could gesture to summon the TLs to huddle, but was instructed to do so if and only if the icons representing the TLs were both in cells adjacent to his own. This constraint was designed to enforce physical proximity prior to calling a huddle.

1. Informed Consent and Demographic Questionnaire

Once the soldiers were seated, the experimenter read a welcome statement that sketched the purpose of the study and told them that they could ask questions at any time

prior to the actual experimental sessions. The experimenter then asked the soldiers to read and sign an Informed Consent Form. The welcome script is attached as Appendix 1. The consent form, Appendix 2, was approved by the Institutional Review Board of the Naval Postgraduate School.

After they had all signed the consent form, they were asked to fill out a short demographic questionnaire. The form is attached as Appendix 3 and is the basis for the information summarized in Table 1.

2. Training Scenario

Because participants were not familiar with C3Conflict, they received a thorough introduction to its interface and controls during a scripted training scenario. The training script is attached as Appendix 4.

The training session was a brief mission during which the experimenter provided oral instructions on the C3Conflict interface, on maneuvering a unit on the map, and on using the chat window to communicate. Soldiers with the fully NW-enabled interface received additional instruction on the use of digital chemlights.

The training session was self-paced. It lasted as long as necessary for all members of the squad to move their units accurately and with confidence, to use the chat window to communicate, and to report they were comfortable with the C3Conflict interface. All 10 squads completed the introductions, forms, and training session within an hour. They then took a short break.

3. Tactical Brief

COL James Riley, USA (Ret.), a career infantry officer with extensive experience in Iraq, wrote the tactical scenarios used in the experiment. The squad received a scenario brief after completing the practice scenario. The brief is attached as Appendix 5.

The brief provides the background story and operating orders for all three components of the cordon and search mission that the squad was to conduct in the experimental scenarios. The background explains that the squad is part of a battalion headquartered near Taji, Iraq during the height of insurgent activities. An active IED cell has been operating with virtual impunity in the vicinity. Intelligence has identified a safe house where the IED cell leader is thought to be. Their platoon has received the cordon and assault mission to kill or capture the IED cell leader. The platoon is to execute a cordon and search conducted in three phases: approach, establishment of the cordon, and assault/search.

All three members of the squad then received two aerial photos covering the area of the cordon and search mission (Figures 1 and 4). Figure 1 is annotated with lines representing every 10th grid coordinate shown by C3Conflict around the edge of the map in the fully NW-enabled condition (Figure 2). Figure 4 is annotated with the three components of the mission: a cordon to the northwest to be established by the First (Red) Squad, a central assault on the objective (the safe house at grid coordinate 40 38) to be conducted by the Third (Blue) Squad, and a cordon to the northeast to be established by the Second (White) Squad. The three experimental scenarios corresponded to the three components of the mission sketched in Figure 4.

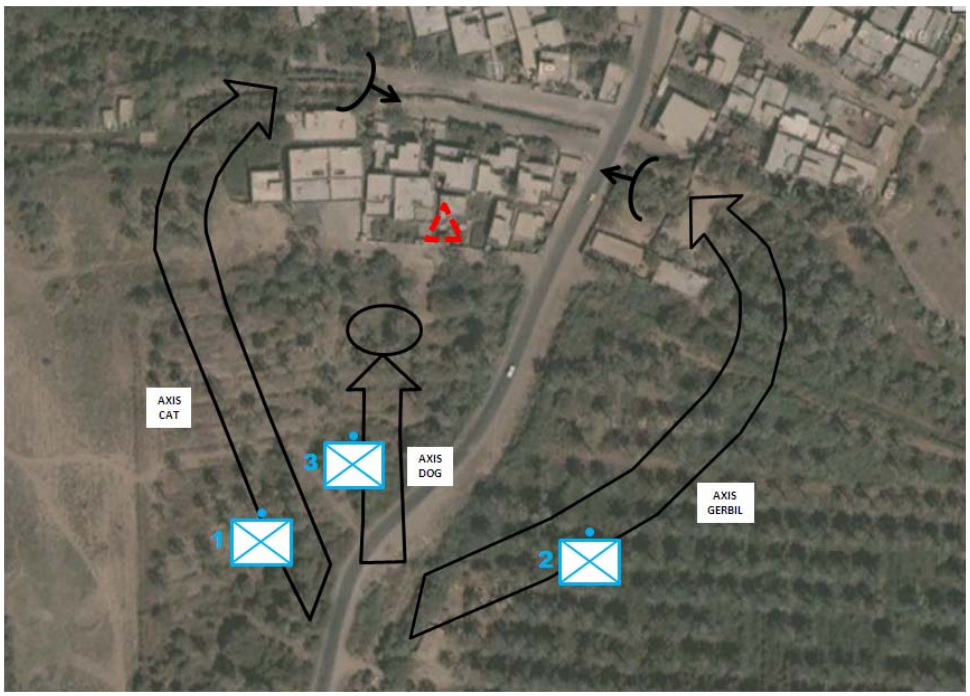

Figure 4. Aerial photo with annotations showing the three components of the search and cordon mission. The red triangle marks the operational objective.

4. Experimental Scenarios

All three components of the mission were conducted in all three experimental scenarios. In the first scenario, the soldiers assumed the role of the Third (Blue) Squad to conduct the assault along Axis Dog (Figure 4). The experimenters assumed the roles of the two squads that established the cordon positions. In the second scenario, the soldiers formed the First (Red) Squad and established the northwest cordon. The experimenters conducted the assault and the other cordon operation. In the third scenario, the soldiers were the Second (White) Squad. They established the northeast cordon, while the experimenters conducted the assault and established the other cordon.

The squad encountered no unexpected activity during the first scenario when it conducted the assault. This scenario was the least complex of the three. It served to build their confidence with the C3Conflict interface and each other and to demonstrate that the mission could be accomplished. The script for the first scenario is attached as Appendix 6.

In the second scenario, the squad moved around the village to establish a cordon to the northwest of the objective. Once there, they received intelligence that the IED leader had moved to a second location within the village (grid coordinate 65 47). Their new orders were to adjust their tactical position to establish a new cordon just west of the main road (grid coordinate 54 52). This scenario was designed to elicit command and control actions relevant to the hypothesis that NW facilitates the emplacement and adjustment of tactical positions. Its script is attached as Appendix 7.

The third scenario was designed to elicit command and control actions relevant to the hypothesis that NW facilitates the reinforcement of an engaged unit. Its script is attached as Appendix 8. In this scenario, the squad moved to the northeast around the village to establish a cordon near the main road. Shortly after the assault began, they received intelligence that the Blue Squad had come under heavy fire, was pinned down, had taken casualties, and needed reinforcement. Their new orders were to reinforce the engaged unit and conduct the assault on the objective. Of the three scenarios, this was the most complex and had the greatest risk of casualties.

Each of the 10 squads engaged all three scenarios in the sequence described. The difficulty presented by the scenarios progressed from simplest to most complex. The order of scenarios was not randomized in order to maximize the potential to observe any practice or learning effects that might emerge. Given the novelty of the C3Conflict interface and its simulation of NW, we expected to observe behaviors indicative of increasing familiarity with the system.

E. MEASURES

C3Conflict captured three types of data that can be used to analyze C2 processes and how they are mediated by NW.

1. Position as a Function of Time

C3Conflict records the position of every unit whenever that position changes. These data are time-stamped and recorded using the grid coordinates shown in Figures 1 and 3. The log of these positions and times is amenable to quantitative analysis.

2. Commands

C3Conflict records and time-stamps every action taken by a soldier including, but not limited to, moving a unit, placing a digital chemlight on the aerial photo, and sending a chat message. The log of these actions is amenable to quantitative analysis.

3. Chat-Based Communications

C3Conflict creates a transcript of all chat communications. The transcript is called a ‘protocol’. It facilitates both qualitative and quantitative analysis of the content of directives and other communications. The method for these analyses is called “protocol analysis.”

F. PROTOCOL ANALYSIS

The first step in any protocol analysis is to develop a scheme that can be used to assign each statement to a unique and descriptive category. The categories in the scoring scheme should be designed to be mutually exclusive and exhaustive. The scoring scheme shown in Tables 3, 4, and 5 was developed for this project to analyze the content of the soldiers’ chat communications. The high-level categories in the scheme, shown in Table 3, were based upon previous work by Doctors Larry and Nita Shattuck of the

Operations Research Department at NPS and by the author (Smith, 2008; Smith, Lindgren, & Granlund, 2006). The subcategories shown in Tables 4 and 5 were added to provide greater detail and to extract data to test several of the hypotheses.

Table 3. Top-level categories used to score the protocol of the soldiers' text-based "chat" communications.

Acronym	Category and Description
L	Pull. Requests for information from another player or the direct reply to a request.
H	Push. Provision of information that was not recently requested by the recipient. Frequently a Situation Report (SITREP).
A	Acknowledgement. An utterance that provides an indication that the speaker has understood an utterance.
D	Directive. Issued by SL to TLs.
S	Script. Any and all communications by the PL or other squads.
C	Coordination. An utterance by a TL that is intended to facilitate squad navigation or synchronization.
RC	Radio Check. An utterance that requests or responds to a radio check.
EH	Clarification sought. An utterance that seeks explanation of something that was unclear.
EX	Clarification provided. An utterance that provides explanation of something that was previously unclear.
BS	BS. Puerile speech that may or may not promote squad cohesion.
PF	Positive feedback. Statements promoting squad cohesion.
EXP	Statements about the Experiment or Interface.
#	Carriage return without text.

The scoring scheme was applied iteratively to the protocol from all 30 missions. There were 2,853 chat messages in total. The first pass through the protocol applied a preliminary set of categories (pull, push, acknowledgment, directive, script, coordination, other) and uncovered the need for the additional categories listed in Table 3. Subsequent passes assigned one of the categories in Table 3 to each message. During this process, it became clear that the SLs were requesting several different types of information from the TLs and that the TLs (and SLs) were providing these and other types of information to the SL (and PL) without being prompted. This finding motivated the development of the subcategories for pulls and pushes in Table 4. A similar process of discovery motivated the development of the subcategories for SL directives to TLs shown in Table 5.

Table 4. Subcategories for Pulls, Pushes, and Scripts used to score the protocol of the soldier's chat.

Pulls	Requests for information from another player or the direct reply to a request
LD	Pull Down. Request by the SL to a TL or by the PL to the SL. A Pull Down is normally followed by a Pull Response or Pull Response SITREP.
LU	Pull Up. Request by a TL to the SL or by the SL to the PL.
LR	Pull Response. Information that is not a SITREP in response to a Pull.
LS	Pull Response SITREP. Information provided by a TL (SL) in response to a pull from the SL (PL) requesting a SITREP.

Pushes	Provision of information that was not recently requested by the recipient
HC	Push/Contact. Information about contact with a hostile or a hostile's position.
HI	Push/In Position. Information about being set at an intended location.
HM	Push/Movement. Information about ongoing movement.
HS	Push/SITREP. Information about personnel, ammunition, and medical condition.
HW	Push/Where. Information about location.
HO	Push/Other. Information about an action other than a player's ongoing movement, location, contact, or SITREP.
HSD	Push Scripted Directive. SL copies or paraphrases PL directive to the squad net.

Scripts	Any and all communications by the PL or other squads
SD	Scripted Directive. An order or command from the PL that is part of the mission script.
SS	Scripted Statement. Information provided by the PL or another SL as part of the mission script.

Table 5. Subcategories for Directives used to score the protocol of the soldier's chat.

Directives	Issued by SL to TL
DD	Direction. A command that makes explicit reference to a cardinal direction ("Move north.") or a relative direction ("B team move to my left flank.").
DF	Follow. A command to follow a specific unit ("Follow me.") or, the fully NW-enabled condition, a trail of chemlights ("Follow the yellow chems.").
DH	Hold. A command to stand by.
DL	Lead. A command to take the lead.
DM	Move. A command to move out or encouragement to move faster.
DP	Plan. A statement of squad-level tactics. ("When we get to that building to the right, let's skirt it to our position.")
DR	Return. A command to join the SL at his location, generally in order to huddle.
DW	Where. A command that explicitly refers to a specific location, building, or road. ("At blocking point A take yellow B take green.")

The complete scoring scheme makes it possible to analyze what was said in addition to how often it was said. Counts of the scoring categories are measures of content. By analyzing the content of the soldiers' chat it becomes possible to identify whether and how the simulation of the alternative BOI influenced the communication used in the exercise of C2. The focus of the analyses presented here was largely on SLs, as they were responsible for translating the (scripted) PL's intent into efficient and effective operations.

The scoring scheme was applied iteratively to the protocol from all 30 missions. There were 2,853 chat messages in total. The first pass through the protocol applied a preliminary set of categories (pull, push, acknowledgment, directive, script, coordination, other) and uncovered the need for the additional categories listed in Table 3. Subsequent passes assigned one of the categories in Table 3 to each message. During this process, it became clear that the SLs were requesting several different types of information from the TLs and that the TLs (and SLs) were providing these and other types of information to the SL (and PL) without being prompted. This finding motivated the development of the subcategories for pulls and pushes in Table 4. A similar process of discovery motivated the development of the subcategories for SL directives to TLs shown in Table 5.

The complete scoring scheme makes it possible to analyze what was said in addition to how often it was said. Counts of the scoring categories are measures of content. By analyzing the content of the soldiers' chat it becomes possible to identify whether and how the simulation of the alternative BOI influenced the communication used in the exercise of C2. The focus of the analyses presented here was largely on SLs, as they were responsible for translating the (scripted) PL's intent into efficient and effective operations.

THIS PAGE INTENTIONALLY LEFT BLANK

V. RESULTS

The discussion of results follows the sequence of hypotheses. Table 6 lists the hypotheses and indicates whether or not they were supported by the data. Both parametric and nonparametric tests were used to ascertain the level of statistical significance of observed differences across experimental conditions.

Table 6, part 1. Hypotheses and results of statistical tests. All hypotheses are one-sided, Full < Partial, unless otherwise noted.

Emergent Behavior	Hypothesis	Supported?	Prob. of Result	Figure #
Coordinated unit navigation				
	N huddles	Yes	.02	5
	N commands to change course	Yes	.03	6
	N commands of all kinds during maneuver	No	1.0	
Emplace and adjust				
	Time to reach cordon position	Yes	.08	7
	Time to move after FRAGO	No	.85	
	N commands to correct positioning	No	.35	
Conduct precise ops				
	Average separation of TL lines from SL line	Yes	.0003	8
	Maximum separation of TL lines from SL line	Yes	.002	9
	Extra distance traveled	No	.23	
Reinforce engaged unit				
	Time to move after FRAGO	No	.85	
	Time to reach assault position	No	.21	

Table 6, part 2. Hypotheses and results of statistical tests. All hypotheses are one-sided, Full < Partial, unless otherwise noted.

Emergent Behavior	Hypothesis	Supported?	Prob. of Result	Figure #
Comms during movement				
	N messages from SL to PL	NA	.56	10
	N messages from SL to TL	NA	.0006	11
	Directives using directions	Yes	.0008	12
	Directives to follow chemlights, Full > 0	Yes	.0076	12, 13
Autonomy				
	Average distance moved in one step	Yes	.03,	14
	Average dispersion of the squad while moving, Full > Partial	No	.35, .76 .82, .88	
Translating leader intent				
	Relaying change in mission	Yes	.03	15
	Use of chemlights to mark tactical positions, Full > 0	Yes	NA	13
Marking the enemy				
	Use of chemlights to mark enemy positions, Full > 0	No	NA	

Note: NA – not applicable

A. COORDINATED UNIT NAVIGATION

Two of the three hypotheses concerning coordinated unit navigation were supported. As expected, there were fewer planning huddles (Figure 5) and changes in course during a maneuver (Figure 6) in the fully NW-enabled condition than in the partially NE-enabled condition. In these figures and others like them, the vertical axis shows the counts of the independent variable, e.g., calls by the SL for a huddle. The first three categories on the horizontal axis correspond to the three missions. They are shown in the sequence in which they were conducted. The final category contrasts the two BOI by averaging across the three missions.

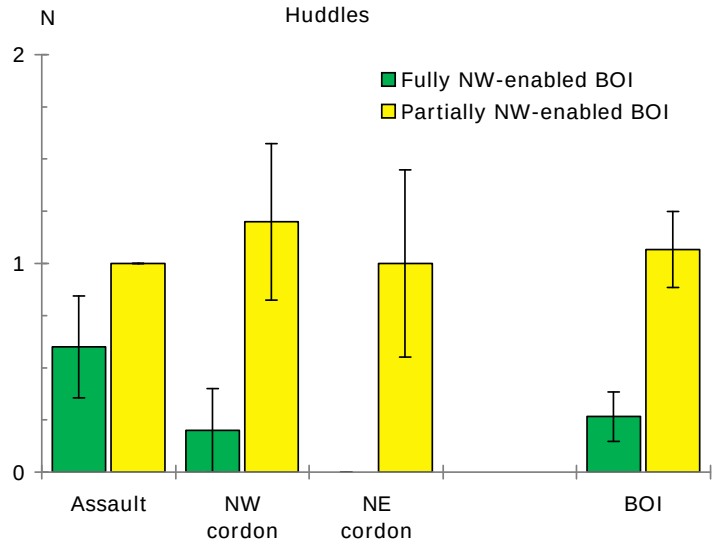

Figure 5. Graph showing the average number of directives to huddle.

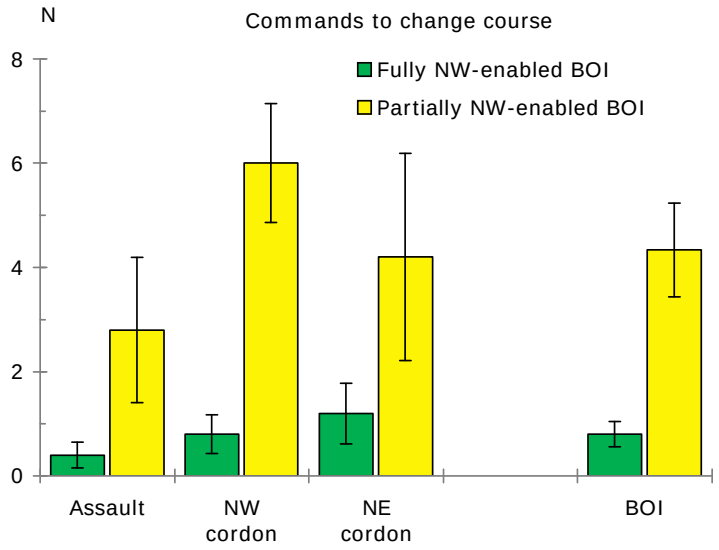

Figure 6. Graph showing the average number of commands to change course during a maneuver.

Both ANOVA achieve significance with impressive levels of power considering the small numbers of observations: $F(1,8) = 9.93$, $MSE = 4.8$, $p < .02$, power = .35 for huddles and $F(1,8) = 7.46$, $MSE = 93.6$, $p = .03$, power = .36 for commands to change course. The strength of both results supports the argument that distributing NW to TLs changes how SLs approach the C2 task of directing maneuvers.

The third hypothesis, that there would be fewer total commands during a maneuver in the fully NW-enabled condition, was not supported. The totals were identical across conditions. Thus, the SL communicated just as often in the two

conditions, but in a different manner (Figures 5 and 6). Additional findings that shed light on the difference in SL to TL communication across the BOI are discussed in the section on Communication during Movement, below.

B. EMPLACEMENT AND ADJUSTMENT OF TACTICAL POSITIONS

Three hypotheses concern emplacement and adjustment. All three were tested using data from the second and third missions. In the second mission, the squad established the northwest cordon position and then received a FRAGO to move to the east to establish a new cordon position. In the third mission, the squad established the northeast cordon position and then received a FRAGO to move south down the main road to reinforce the assault squad that was taking fire.

The measure used to test the hypothesis about emplacement was the time between (1) when the PL issued the directive to move out from the dismount location and (2) when the squad was set at its initial cordon position. This measure supported the hypothesis. The average times to reach the positions are shown in Figure 7. The differences are in the expected direction, but do not reach the standard .05 level of statistical significance, $F(1,8) = 3.98$, $MSE = 58104.$, $p = .08$, power = .20. With a larger data set, it is highly likely that this measure would become statistically significant. Pragmatically, this result supports the hypothesis.

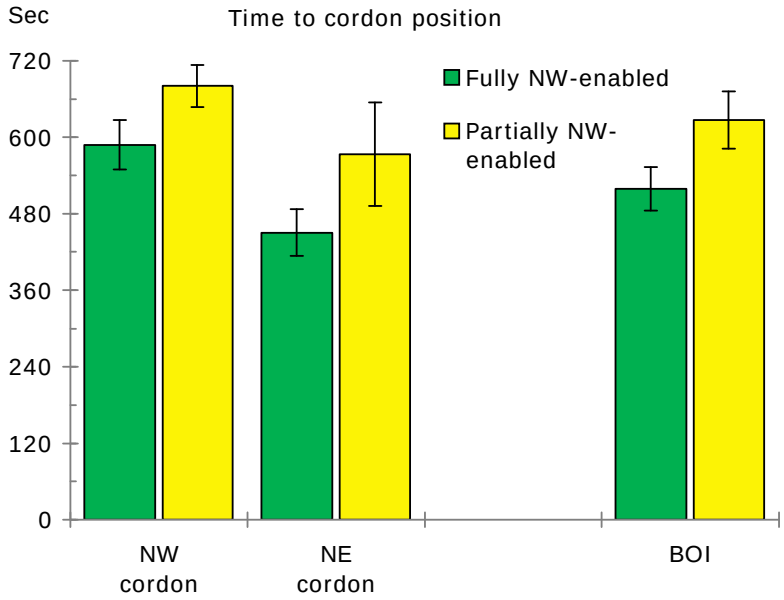

Figure 7. Graph showing the average time in seconds to reach, establish, and announce set at the initial cordon position.

The second measure was the time to adjust positions following the FRAGO to do so. This measure did not support the hypothesis. The squads did not have far to go and they always hustled.

The difference in these results may reflect a combination of factors. The first is the degree of stealth required. Moving quietly prior to the assault on the safe house was a

major concern when establishing the initial cordon positions. This was not a concern after the original mission had been compromised. The second is the difference in the distances and relative directness of the routes to be taken. The routes from the dismount point to the initial cordon positions involved moving around the village. In contrast, the routes following the FRAGOs were short and travel was relatively fast.

The third hypothesis relevant to emplacing and adjusting positions concerned the number of commands issued by the SL to reposition the TL upon arrival at the assault or cordon position. There was no difference across the experimental conditions. This null result is consistent with the interpretation that soldiers do not need the capabilities offered by NW to execute well-drilled activities in close quarters.

In sum, the fully NW-enabled condition may enhance a squad's ability to move quickly and stealthily. It does not appear to have an effect on either the SL's need to reposition TLs upon arrival or on the squad's movement directly down a main road when a mission has been compromised.

C. CONDUCT PRECISE OPERATIONS

Three measures were analyzed to test hypotheses about the precision of squad-level operations. Two of the measures reflect the assumption that the precision of movement is best when TLs take the same line as their SL. Thus, precision varies inversely with the difference between (1) the line taken by TLs while moving from the dismount point to the initial cordon or assault position and (2) the line taken by their SL. It is worth noting that these operations require stealth.

Figure 8 is a graph of the average distance between lines taken by TLs and their SL. Figure 9 shows the maximum separation during this move. We predicted that both measures would be less in the fully NW-enabled condition. Both hypotheses were confirmed. The average separation was highly significant, $F(1,8) = 20.39$, $MSE = 2.46$, $p = .0003$, power = .64. The maximum separation was also significant, $F(1,8) = 13.06$, $MSE = 19.19$, $p = .002$, power = .49. The strength of these two results supports the argument that a rifle squad's ability to conduct precise operations while moving stealthily is greatly enhanced by the fully NW-enabled BOI.

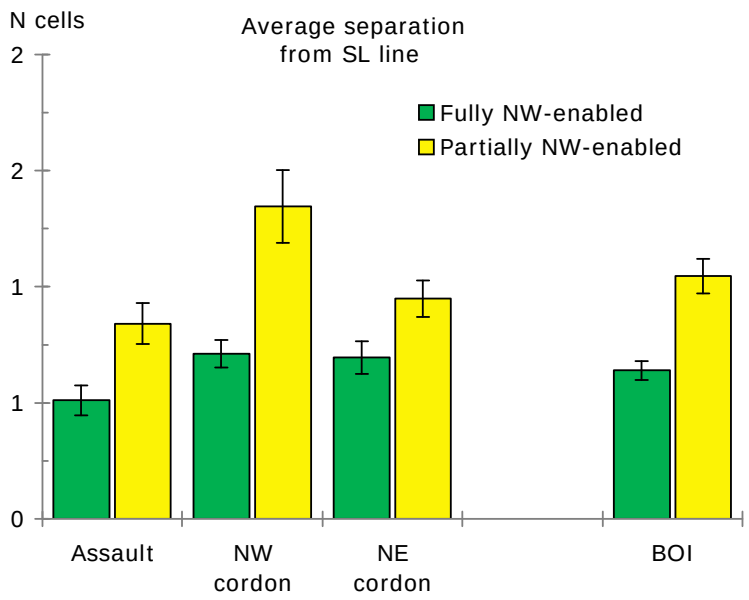

Figure 8. Graph showing the average separation between the lines taken by TLs and the line taken by their SL. The unit of measurement is a C3Conflict cell, a square nominally five meters on a side.

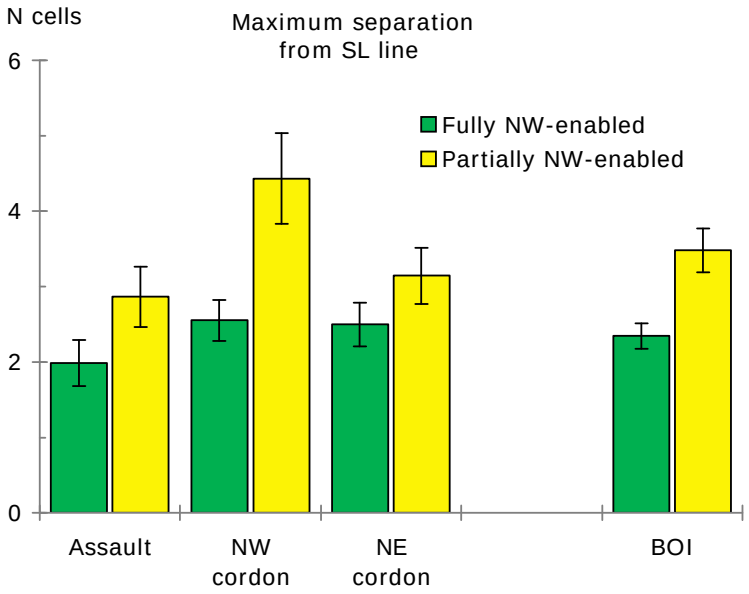

Figure 9. Graph showing the maximum separation between the lines taken by TLs and the line taken by their SL. The unit of measurement is a C3Conflict cell, a square nominally five meters on a side.

The final hypothesis for this emergent behavior was that the difference in the lengths of the routes taken by TL and the route taken by their SL would be less in the

fully NW-enabled condition. The unit of measurement was the number of C3Conflict cells. This hypothesis was not supported. The differences were in the anticipated direction for all three missions, but the variability across individual TL was equally large. This is the first of two measures to be reported for which individual differences were as large as any effect that could be associated with NW.

D. REINFORCEMENT OF AN ENGAGED UNIT

We tested two hypotheses associated with the reinforcement of an engaged unit, the time to move out following a FRAGO and the time taken to reach the support by fire position. Neither hypothesis was supported. While both were in the anticipated direction, the likelihood of these measures reaching statistical significance is slim.

This finding may be an artifact of the scenario used in this experiment to evaluate this hypothesis. The route to be taken following the FRAGO was short. Travel was in a straight line down a major road and, accordingly, relatively fast. There was no need for stealth. In retrospect, this scenario did not require the SL to take full advantage of NW. In future studies it would be possible to improve the design of the scenario to improve the opportunity to observe differences across conditions.

E. COMMUNICATION DURING MOVEMENT

The discussion in this section covers a range of topics relevant to squad communications that emerged during the protocol analysis in addition to the two hypotheses concerning communication during movement.

Approximately 10% of the chat messages were sent from the SL to the PL (286 of 2,853). Figure 10 shows the distribution of those messages across all categories of SL to PL chat. These categories and their acronyms are listed in Tables 2 and 3. Even though the distributions are similar and not significantly different, chi-square (7) = 5.84, $p > .55$, inspection of Figure 10 reveals that SL in the fully NW-enabled condition pushed more messages to the PL than SL in the partially NW-enabled condition. Specifically, they pushed more information about contact with the enemy and the squad's position and movement status. These data are consistent with the argument that the fully NW-enabled BOI makes it possible for the SL to take the time to push more battlefield-relevant information up the chain of command.

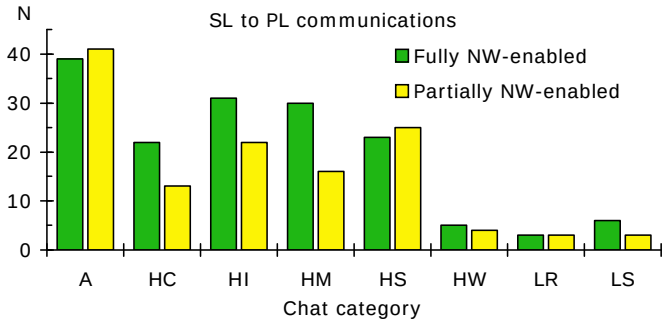

Figure 10. Graph showing the distribution of the total counts of chat communications from the SL to the PL in the 30 missions.

Of the 657 messages from SL to TL, 424 were directives: mission-relevant commands. Figure 11 shows the distribution of directives across the categories listed in Table 5. A chi-square test found the distributions to be significantly different, chi-square (7) = 25.6, $p < .0006$. While the distributions may appear to be the same, they are not. Two categories, commands that made explicit references to cardinal or relative directions (DD) and commands to follow (DF), vary in opposite directions and contribute prominently to the chi-square calculation. SLs in the fully NW-enabled condition gave fewer than half as many directional commands as SLs in the partially NW-enabled condition. Instead, they issued commands that efficiently and accurately referred to common operational graphics, e.g., "Follow the yellow chems."

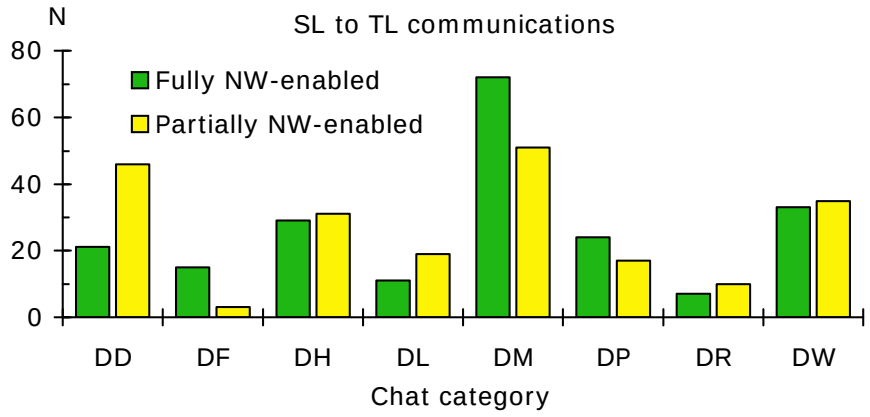

Figure 11. Graph showing the distribution of the total counts of chat communications from the SL to TLs in the 30 missions.

The two sets of commands issued to guide squad movement are highlighted in Figure 12. As predicted, both differences are highly significant, chi-square (1) = 11.34, $p = .0008$ for commands using cardinal or relative directions and chi-square (1) = 7.12, $p = .0076$ for commands to follow. These results are consistent with the argument that the fully NW-enabled BOI fundamentally changes how SL approach the C2 task of directing their squads to maneuver. They spend much less time and effort telling TLs precisely where and how to move. Instead, they post chemlights on the shared map and tell TLs to follow the path.

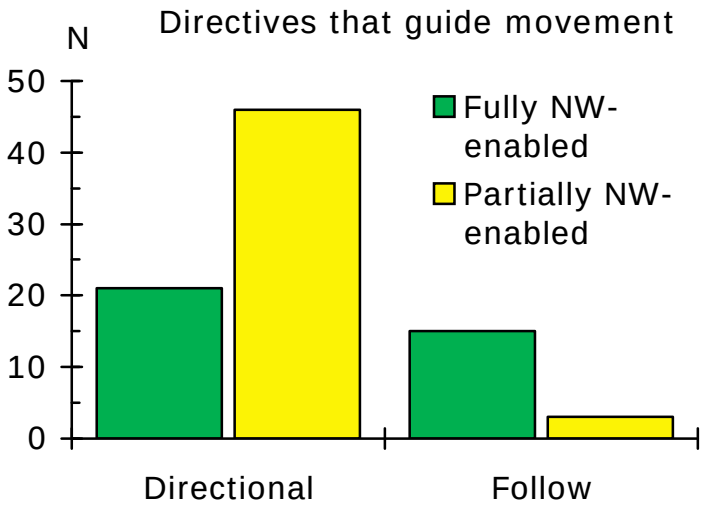

Figure 12. Graph showing the number of directives that specified moving in a cardinal or relative direction or that specified following the SL or chemlight trail.

Four typical examples of chemlight use by SLs in the fully NW-enabled condition are shown in Figure 13. The panel in the upper left shows how one of the SL used chemlights to direct the assault on the objective in the first mission. The two panels on the right show how two different SL in different missions used chemlights to show TLs the routes to take to their cordon positions in the second and third missions. The panel in the lower left shows how an SL directed TLs to the second cordon following the FRAGO to adjust position in the second mission. In all four cases, the SL used the capabilities of NW to create a common operating picture about where and how they wanted the squad to move.

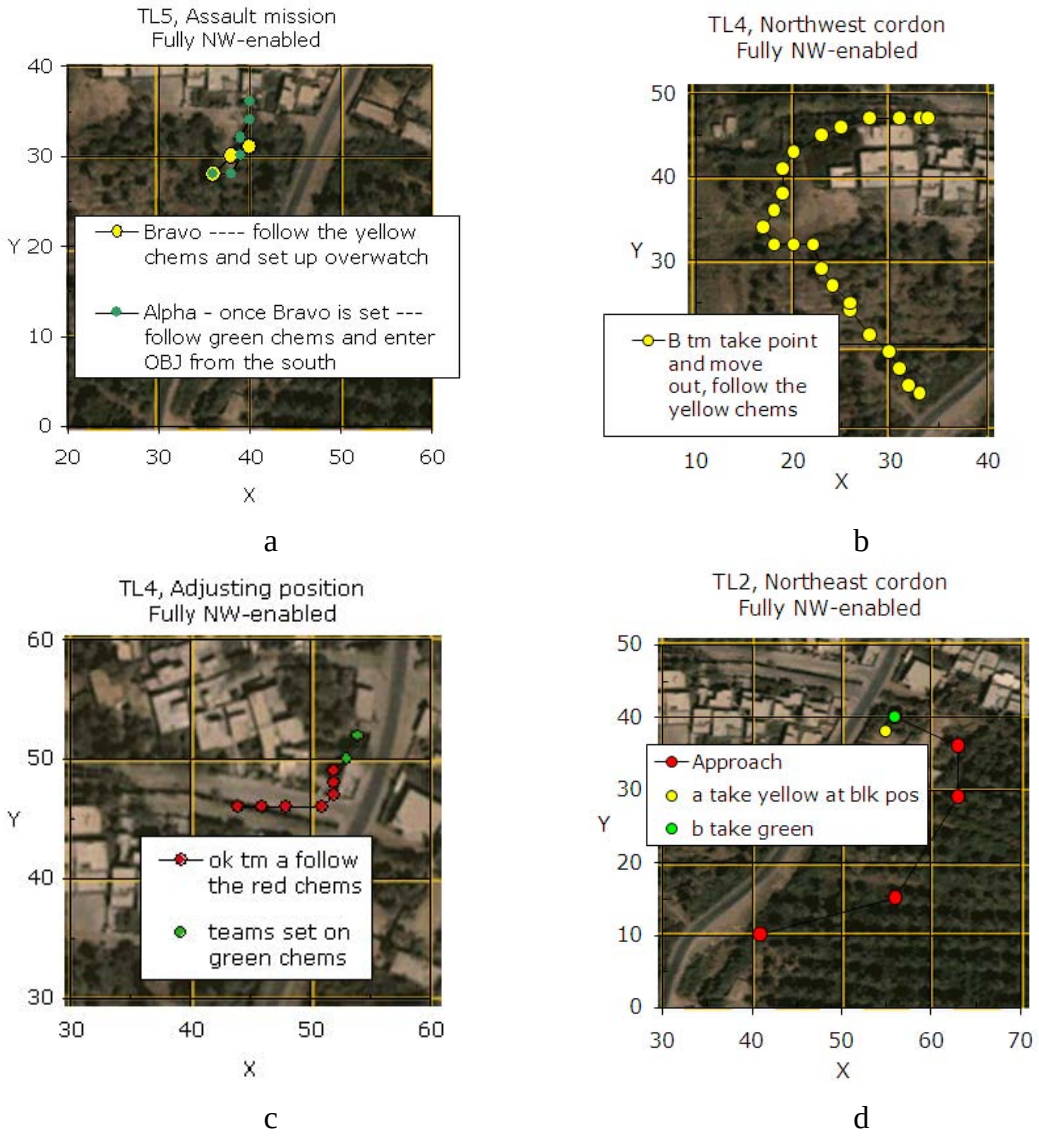

Figure 13. Four examples of chemlight use by SLs in the fully NW-enabled condition. (a) An assault on the objective. (b) Approaching the northwest cordon position. (c) Adjusting that position. (d) Approaching the northeast cordon position.

F. AUTONOMOUS/DECENTRALIZED MOVEMENT

To test the hypothesis about the enhancement of TL autonomy in the fully NW-enabled condition, we measured the distances that TLs moved their icons on the C3Conflict map. The unit of measurement was the C3Conflict cell. The minimum distance that an icon can be moved is one cell. A diagonal move (e.g., to the northeast) has a distance of 1.4 (root 2) cells.

When comparing across experimental conditions, it is important to remember the constraints imposed by the two displays, Figures 1 and 2. TLs in the fully NW-enabled

condition could see a 40x40 area of cells, Figure 1. The maximum distance they could move their unit was to the edge of the map. If the map was centered on the TL's current location, this distance could be as great as 28 (20 root 2) cells. In contrast, TLs in the partially NW-enabled condition could see only a 20x20 area of cells that was always centered on their current position (Figure 2). To remain within visible range, the greatest distance the TL could move was 14 (10 root 2) cells.

Figure 14 is a graph of the average distance that TLs moved their icons on the map during the move from the dismount point to the initial assault or cordon position. These are the operations that required stealth. The differences across BOI are highly significant and are evident in every mission, $F(1,8) = 5.81$, $MSE = 24.84$, $p = .03$, power = .52. This result strongly supports the claim that a soldier in the fully NW-enabled BOI is likely to feel sufficiently informed and empowered to move further before pausing to regroup or reassess his progress during a mission that requires stealth.

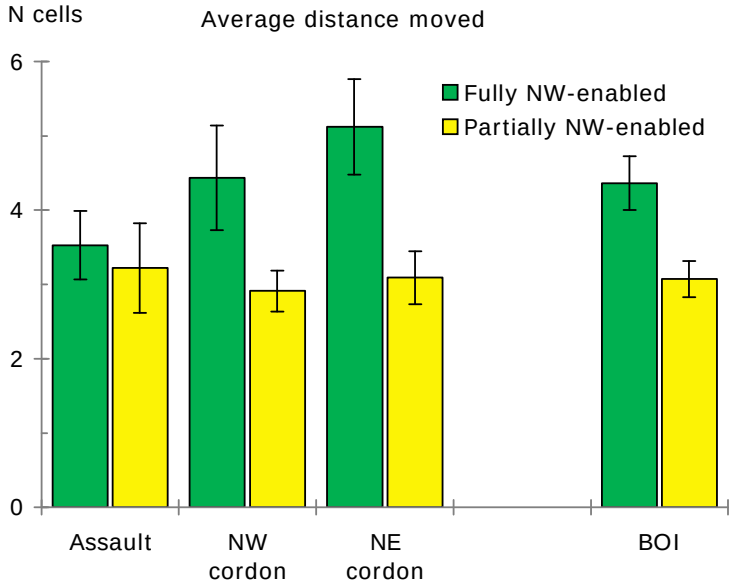

Figure 14. Graph showing the average number of C3Conflict cells that TLs moved their units on the map.

The inference about soldier empowerment is indirectly supported by the significant and systematic increase in the average distance moved across the three missions in the fully NW-enabled condition. As shown in Figure 14, TLs moved with increasingly larger steps as they became more familiar with the emulation of NW. In contrast, TLs without NW did not change how they moved.

To test the hypothesis about the dispersion of the squad while moving, we looked at four measures: (1) the distance between the outermost two members of the squad in the direction perpendicular to the squad's line of travel; (2) the "tip to tail" distance between the lead member and the trailing member of the squad in the direction of the line of travel; (3) the distance between the two TLs independent of orientation; and (4) the total of the three distances between the three members of the squad. None was significantly different. All four measures are dominated by variability across squads.

This is the second of the two measures that individual differences appear to have made relatively insensitive to any impact that NW might have on squad operations.

G. LEADER'S INTENT REMOTELY TRANSLATED

During both the second and third missions, the SL received a FRAGO from the PL (an experimenter) to move the squad from its initial cordon position. The transcripts of the chat messages reveal the elapsed time between when the SL received the FRAGO (on the platoon net) and when he passed it along to the TL (on the squad net). As shown in Figure 15, this time was significantly quicker in the fully NW-enabled condition, $F(1,8) = 7.20$, $MSE = 24221.$, $p = .03$, power = .28.

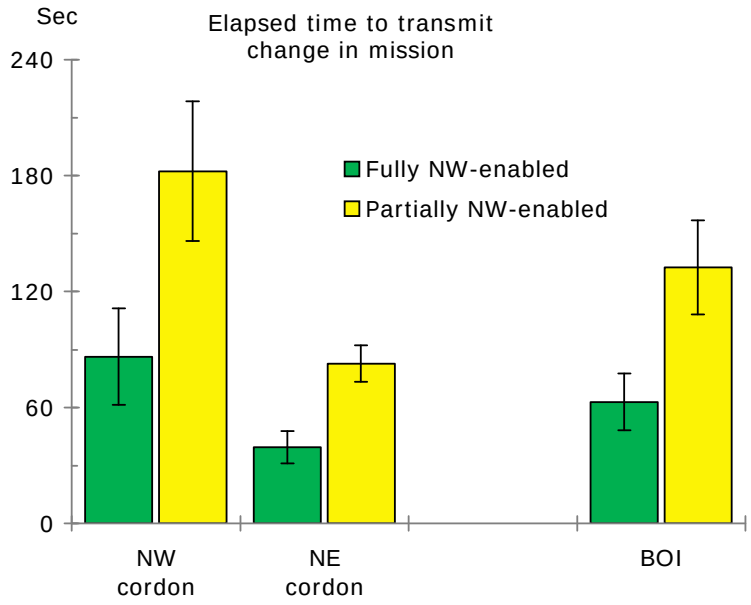

Figure 15. Graph showing the average time in seconds for a SL to transmit or translate or both a FRAGO from the PL to the TL.

Many SLs in the fully NW-enabled condition used the copy and paste functions of the chat window to expedite the transfer of information. They copied the FRAGO from the platoon net and pasted it to the squad net and sent it to the TL. This action gave TLs the chance to read and digest the FRAGO for themselves. This exercise of empowerment never happened in the partially NW-enabled condition. This difference may reflect a tacit acknowledgment by many SLs that fully NW-enabled TLs possess a sufficiently accurate COP to contribute meaningfully to the squad's response to a FRAGO.

The second hypothesis concerning leader's intent proposed that SLs in the fully NW-enabled condition would use chemlights to mark tactical positions. The hypothesis was supported. Two examples are shown in the lower panels of Figure 13. In the panel on the lower left, the SL posted two green chemlights and let his TL choose between them. In the panel on the lower right, the SL directed Alpha Team to the yellow chemlight and Bravo Team to the green chemlight. These examples show SLs taking full advantage of this capability of NW and tailoring its use to fit their styles of command.

As this type of communication was not possible in the partially NW-enabled condition, no statistical test can be conducted.

H. MARKING ENEMY POSITIONS ON THE COMMON OPERATING PICTURE

The one hypothesis about using chemlights to mark enemy position was not supported. This null result reveals more about the conduct of the experiment than it does about the contrast in BOI. The experimenter playing the role of PL placed chemlights on suspected enemy positions at the beginning of every mission. Whenever the soldiers came within visual range of an insurgent (i.e., entered the objective house), the experimenter playing the role of the insurgents placed a symbol on the map revealing the presence of an enemy. This symbol immediately drew fire from the soldiers. As soon as the soldiers killed the enemy, the experimenter changed the symbol to mark the kill. As a result, the soldiers had no need to use chemlights to mark enemy positions.

THIS PAGE INTENTIONALLY LEFT BLANK

VI. DISCUSSION

In this section, we recapitulate the experimental findings by presenting analyses of their implications for the BOI decision.

There are two clusters of results that support the fully NW-enabled BOI. First, SLs in the fully NW-enabled condition communicated more effectively. Second, squads in the fully NW-enabled condition moved more efficiently when stealth was required. These two direct benefits are interpreted to manifest themselves as a reduction in SL workload and in enhanced TL autonomy, empowerment, and responsibility. These direct and indirect benefits are discussed in turn. The section ends with a summary of the limitations of the experiment and the experimental platform.

A. THE FULLY NW-ENABLED BOI IMPROVES THE FLOW OF INFORMATION UP AND DOWN THE CHAIN OF COMMAND

Six of the confirmed hypotheses relate to the flow of information and the creation of a common operating picture. SLs in the fully NW-enabled condition called fewer huddles (Figure 5), issued fewer commands to change course (Figure 6), and issued fewer commands that relied on cardinal or relative directions (Figure 12). Instead, they made extensive and effective use of digital chemlights (Figure 13) and of commands to follow them (Figures 12 and 13). In addition, they pushed more battle-relevant information to PLs (Figure 10), were faster to relay FRAGO from the PL to their TLs (Figure 15), and used chemlights to mark tactical positions (Figure 13).

The fully NW-enabled BOI provides the SL with more choices and greater flexibility in how to communicate up and down the chain of command. The SLs who were able to use the digital chemlights were freed from having to call time-consuming huddles and from the need to fine-tune their squad's movement. Once they had posted the line to follow and the tactical positions to take on the common operating picture, the SLs were free to provide more information to the PL. Their TLs knew what to do and the PL knew what they were doing. In sum, the fully NW-enabled BOI makes it easier for SLs to do this part of their job well.

B. MOVEMENT

Four of the confirmed hypotheses reveal the manifold ways that the fully NW-enabled BOI can improve squad movement. When stealth is required, squads moved faster (Figure 7), with more precision (Figures 8 and 9), and more autonomously (Figure 14). The design of the experimental missions may have precluded observing similar benefits when the primary mission had been compromised and stealth was no longer a constraint on movement.

This combination of benefits is remarkable and can likely be traced to a shared operating picture populated by digital chemlights that form a line to follow. The common picture freed TLs to connect the dots. They moved further with each step in precisely the right direction. This, in turn, enabled the squad to move faster and, it is

inferred, with greater stealth. In sum, the fully NW-enabled BOI makes it easier for TLs to do this part of their job well.

C. THE FULLY NW-ENABLED BOI DECREASES SL WORKLOAD

The experiment uncovered systematic differences across conditions and improvements in unit operations in the fully NW-enabled condition. It is reasonable to infer that both the changes in communication and the improvements in squad movement would contribute to a reduction in SL workload in the fully NW-enabled BOI.

Issuing NW to TLs allows SLs to use the digital chemlights to direct squad movement and to issue simple, easily understood directives such as "follow the red chems" (Figure 13). This is surely less effortful, both mentally and physically, and less time-consuming than assembling the squad in a huddle, issuing detailed verbal instructions, and insuring the instructions are understood. Issuing NW to TLs reduces the need for the SL to take the time and effort to fine-tune squad movement (Figures 7 and 12). This offloading of time-consuming and effortful tasks should reduce SL workload.

Time pressure is one of the major sources of workload in any dynamic environment. The observation that SLs, in the fully NW-enabled condition, had and took the time to push information up the chain of command (Figure 10), suggests that they felt less time pressure. Further, it is likely that the act of pushing information further reduces SL workload: it is an act that empowers others who are less likely to be in the line of fire to weigh options and make time-critical decisions in a thoughtful manner. SLs who know that their PLs are fully informed are less likely to be debilitated by time pressure and workload.

The concomitant improvements in squad performance in the fully NW-enabled condition are likely to act like a prescription for reduced SL workload. The mental effort of leadership is surely reduced when SLs know that their TLs are likely to take the right path quickly and efficiently.

Any reduction in SL workload during the execution of a mission is beneficial. When workload is relatively low, SLs are better able to respond to unexpected situations, to remain in control of the squad, to devote time and attention to planning and anticipating the unfolding course of the mission, and to keep the squad and superiors better informed.

D. THE FULLY NW-ENABLED BOI INCREASES TL AUTONOMY, EMPOWERMENT, AND RESPONSIBILITY

TLs in the fully NW-enabled condition moved faster, further, and more precisely. It is likely that a soldier who performs better knows that he is performing better. The soldier who knows he can move stealthily will have greater confidence in himself and his squad. This knowledge, if sustained and reinforced, would likely manifest itself as a sense of autonomy, empowerment, and responsibility. It would also promote team cohesion. Finally, and perhaps most critically, the self-confidence promoted by the fully NW-enable BOI would likely to endow TLs with the sense that they would be able to assume command were the need to arise.

E. LIMITATIONS OF THE C3CONFLICT EXPERIMENTAL PLATFORM

1. Unit Navigation

C3Conflict representation of leader/fire team movement and navigation provided continuous location and intended destination display, which also defined the individual's orientation on the digital imagery. Navigation was not explicitly represented. Actual movement routes between participant designated points were automatically selected and executed by the computer using a straight line algorithm, which eliminated the possibility of deviation from the path due to inattention or inadequate location tracking by the participant. Consequently, it was impossible to get lost, which is quite unrealistic.

2. Distortion of Distances

The experimental instructions informed the soldiers that the square cells in the C3Conflict map had sides five meters in length. This length was chosen to match the sizes of the buildings in the aerial photo. The speeds with which soldiers moved through the terrain were scaled to this 5-meter cell size, Table 2. Accordingly, both the imagery and movement rates reinforced the 5x5 meter cells.

Nevertheless, there is evidence in the soldiers' chat that several of them vastly overestimated the cell size. Here is an illustrative example: "We just covered 2k in less than a minute. That's pretty good!" The squad had, in fact, crossed 15 cells, 75 meters, in two minutes. It is unclear how pervasive this distortion was. If, in fact, soldiers routinely assumed that 15 cells were the equivalent of two kilometers (rather than 75 meters), then the differences in distances across conditions shown in Figures 8, 9, and 14 scale to hundreds of meters.

3. Common Operational Picture (COP)

C3Conflict representation of the COP was very good in terms of providing continuous individual leader location and individual icons for every other NW-equipped leader within a designated organization. The model was limited in its ability to mimic fully the friendly and enemy operational graphics and symbols made available by NW. Participants were provided with paper copies of the area of operations imagery with base-friendly graphics and enemy situation template depicted to mitigate this shortcoming in NW capability representation. The model display provided a single scale digital image of the area of operations without operational graphics or situation templates. The resolution of the single digital image was approximately 1:25,000, which is adequate for participant computer-based execution of the tactical plan, but far less than the capability provided by NW.

C3Conflict also does not represent the target acquisition, identification, and engagement decision cycle of actual lethal fires and effects application. Direct fire engagements were computer automated events, based upon proximity rules. As such, leaders were not required to implement either directive or procedural controls over direct fire engagements. Fratricide and any evaluation of NW-enabled awareness impacting its likelihood of occurrence was, therefore, not possible.

4. Command and Control (C2)

C3Conflict representation of the digital chemlight capability was excellent. Participants made frequent and realistic use of the capability to direct the actions of NW-enabled subordinates and rapidly mark significant location-based information events on the digital display.

The single scale digital image of the area of operations without operational graphics or situation templates, while adequate for computer-based execution of the tactical plans, probably limited the tactical sophistication of squad actions on the objective to some degree. One-meter or even submeter level imagery might have generated additional clarity and detailed tactical arrangement of forces leading up to and during the assault of the target building. Participant questions about courtyard wall heights, number of building stories, target building entry points, and some confusion whether a shape on the digital image was a building or an open area probably could have been answered with higher resolution imagery.

APPENDIX 1. WELCOME

Naval Postgraduate School

Welcome

Welcome. You are invited to participate in a research study on the (Squad Leader / Team Leader) Basis of Issue of the Ground Soldier System / Land Warrior (GSS/LW).

The three of you are members of a squad that will be part of a platoon-level cordon and search mission in Iraq. The focus of the study is on command and control, not on weapons use.

(Rank Name)_____, you are the Squad Leader.
(Rank Name)_____, you are the leader of Alpha Team.
(Rank Name)_____, you are the leader of Bravo Team.

You three represent the squad leadership. Your squad will receive orders from a platoon leader directing you to move from a Stryker vehicle dismount point to either an assault position or a blocking position. The designated assault element will then attack the target location to engage and eliminate an IED cell. You will receive additional information about your specific mission soon.

This study is computer-based. The computer interface enables you to move an icon that represents you (for Squad Leaders) or you and your team (for Team Leaders) on a map by clicking and pointing. The computers are linked so that each of you can see on the map all icons in the immediate vicinity (with 50 m). GSS-enabled leaders will be able to see icons beyond the line of sight. There will be other icons on the map that represent (1) the Platoon Leader, (2) the Squad Leaders and Team Leaders of two other squads, and (3) members of the IED cell.

The computers are configured to present information in a manner that emulates the information that is available in the (Squad Leader / Team Leader) Basis of Issue of the Ground Soldier System (GSS).

You will receive training on how to use the computer interface to move your icon, to communicate with each other, to receive orders from the platoon leader, and to engage the enemy.

You will then participate in three sessions. In the first session, your squad will be the assault element. In the second and third sessions, your squad will be a cordon element assigned inner-cordon tasks.

Before we proceed, I am required to ask you to sign an Informed Consent Form.

Any questions?

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX 2. INFORMED CONSENT FORM

Naval Postgraduate School

Consent to Participate in Research

Introduction.

You are invited to participate in a research study entitled Quantitative evaluation of squad and team leader performance with and without GSS (QUEST±GSS). The study is being conducted on behalf of TRAC Monterey.

Voluntary Nature of the Study.

Your participation in this study is strictly voluntary. If you choose to participate you can change your mind at any time and withdraw from the study. You will not be penalized in any way or lose any benefits to which you would otherwise be entitled if you choose not to participate in this study or to withdraw. If you decline to participate you will return to your normal duties.

Potential Risks and Discomforts.

There are no foreseeable risks of participating in the study. You will be asked to sit at a computer terminal for 3 sessions each lasting approximately 30 minutes. Between computer sessions you will be free to stretch and have coffee, etc.

Anticipated Benefits.

Anticipated benefits from this study are data that will inform the decision of how to distribute the ground soldier system (GSS) to squads. The GSS is expected to improve command and control and squad performance. You will not directly benefit from your participation in this research.

Compensation for Participation.

No tangible compensation will be given. A copy of the research results will be available at the conclusion of the experiment from TRAC Monterey.

Confidentiality & Privacy Act.

Any information that is obtained during this study will be kept confidential to the full extent permitted by law. All efforts, within reason, will be made to keep your personal information in your research record confidential but total confidentiality cannot be guaranteed.

We are not collecting any information about you personally other than your rank and role in your squad (e.g., squad leader, team leader, rifleman). We do not record your name or any other identifiers. The computer you will use has a number. The data that will be stored refers to the computer number, not to you.

However, it is possible that the researcher may be required to divulge information obtained in the course of this research to your chain of command or other legal body.

Points of Contact.

If you have any questions or comments about the research, or you experience an injury or have questions about any discomforts that you experience while taking part in this study please contact the Principal Investigator, Dr. Kip Smith, cssmit1@nps.edu. Questions about your rights as a research subject or any other concerns may be addressed to the Navy Postgraduate School IRB Chair, Dr. Lawrence Shattuck, lgshattu@nps.edu, 831-656-2473.

Statement of Consent.

I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

…….	…….
Participant's Signature	Date
…….	…….
Researcher's Signature	Date

APPENDIX 3. DEMOGRAPHIC QUESTIONNAIRE

QUEST±GSS

Demographic Information

This form has two sides

Date _____ Code # _____

Rank _____

Have you served as a Platoon Leader? Y N

Have you served as a Squad Leader? Y N

Have you served as a Team Leader? Y N

Gender M F

Age _____

Years of Service _____

Have you deployed in Iraq or Afghanistan since April 2003? Y N
How many deployments? _____
How many months total? _____
How many times did you conduct a patrol on foot?_____
How many times did you conduct a vehicle-mounted patrol?_____

Do you play video games?_____
How many hours a week?_____

How many emails do you send in an average day?_____

How many text message do you send in an average day?_____

Experience with the Ground Soldier System / Land Warrior (GSS/LW)

Have you used the GSS/LW in theater? Y N

Have you participated in a study of the GSS/LW? Y N

Are you familiar with the GSS/LW? Y N

If you answered Yes to one or more of the last three questions, please describe your experience with the GSS/LW on the back of this page.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX 4. TRAINING SCRIPT

TRAINING MISSION

Set up

TrainingForSLboi.con or TrainingForTLboi.con
NotTaji.sce
TNG Area 2.gif

5 computers:

1 Manager & PL
2 Insurgents
3 Red Squad Leader
4 Alpha Team Red Squad
5 Bravo Team Red Squad

Start manager, Select PL and Insurgents

Participant selects his roles and see his icon

Please double click on the C3Conflict icon in the upper right corner of the screen.

Click Run

Three screens will appear, black, white and a brown response screen.
The brown screen takes some time to show up. When it appears,

Click Player

(Rank Name)_____, you are the Red Squad Leader. Click the button.

(Rank Name)_____, you are the leader Alpha Team Red Squad. Click the button.

(Rank Name)_____, you are the leader of Bravo Team Red Squad. Click the button.

Click the OK button in the yellow box.

About the experiment

In this training session, you will become familiar with the computer interface by practicing moving your icon on the map and by sending and receiving chat messages.

Team Leader condition

This experiment is investigating the effects of the Team Leader (full) basis of issue of the Ground Soldier System. You have all been issued the GSS system.

Each of you has a map view of the world that shows your location and the locations of others in your platoon. Each of you has a chat window for communications and can place dots - digital chem. lights - on the map to facilitate that communication.

Squad Leader condition

This experiment is investigating the effects of the Squad Leader (partial) basis of issue of the Ground Soldier System. The Squad Leaders has been issued the GSS but the Team Leaders have not.

What this means is that you have different displays and access to different sources of information. However, each of you has a chat window for communications.

Map

Here is a map of the training area. These are the grid coordinates.

Questions

If you have any questions during the training session, feel free to ask at any time. During the experiment, if you have a technical question or run into a problem with the interface, raise your hand and we will help you.

The parts of the interface

The interface contains a map, a chat window, and several information boxes.

Map

The map shows a satellite image of the area. The map consists of a grid of cells. Numbers above and to the left of the map are the grid coordinates.

The one icon that you see on the map represents YOU (and the other members of your team) and YOUR position. You have dismounted from a Stryker and are waiting for orders to move out.

Squad Leader -- That icon, with the number 1, represents you, individually. That is your position in the map grid.

Team Leaders -- That icon, with the letters 1A or 1B, represents you and the three other members of your team. The four of you occupy the same cell in the map grid.

Team Leader condition: Same Maps

All of you have been issued the GSS/Land Warrior. As a result, all three of you see the same information on the same map.

Squad Leader condition: Different Maps

Only the Squad Leader has been issued the GSS/Land Warrior. As a result, you three are looking at different maps.

Team leaders -- move to look at the Squad Leader's Screen. The GSS enables him to see a lot more of the world than you.

Squad Leader -- look at one of the Team Leaders' screens. He has no GSS. His map shows only that part of the world within his line of sight.

Chat

To the right of the map is the chat window. Think of it as your radio / chat tool. The upper portion is where you receive communications. The lower portion is where you type the message you want to send. Click on the send button below the window to actually send a message. Hitting return inserts a line. It does not send your message.

Team Leaders - you have one send button. The Squad Net. Use it to send messages to the Squad Leader and to the other Team Leader.

Squad Leader - you have two send buttons. One of the Platoon Net and one for your Squad Net. You will receive orders and SIGINTS from the Platoon Leader on the Platoon Net. To send messages to the Team Leaders, you need to use the Squad Net.

Chat or Huddle

Now, an important point: With one exception, we do not want you to talk or shout during the experiment. For all radio communications, use the chat window. Is that understood?

There is one exception. When the Squad Leader wants to bring the Team Leaders to him, we can call for a 'huddle'. Your icons must be in adjacent cells on the map and then you can get out of your chair and walk over to Squad Leader. The three of you can then make plans or 'draw in the sand', etc.

Unit Palette, etc.

Across the top of the screen are boxes with useful information. On the left is the clock.

The most important of the boxes is the Unit Palette. It contains a single white icon that represents you (SL) or you and your team (TL). To the right of the icon is the short-hand name for you or your team.

You will be pointing and clicking on the icon and/or name in the Unit Palette to indicate that you want to move your icon on the map.

Symbol Palette: Chem Lights

One of the features of the GSS/Land Warrior is the ability to put digital chem. lights on the map.

Team Leader BOI:

As you have all been issued the GSS/Land Warrior, each of you has a Symbol Palette. The Symbol Palette enables you to place and see chem lights on the map. The chem. lights are represented by colored dots. Once the practice session starts, you will practice placing chem. lights on the map.

Squad Leader BOI:

Squad Leader - you have a Symbol Palette but the Team Leaders do not because they have not been issued the GSS/Land Warrior. The Symbol Palette enables you to place and to see chem lights on the map. The Team Leaders will not see the chem. lights on the map. Once the practice session starts, the Squad Leader will practice placing chem. lights on the map.

Questions

Any questions about the interface and its layout?

Start the Session

I am going to start the session now. Don't do anything yet. Look at what happens on the screen.

<Start>

Icons

As soon as the session starts, icons appear that represent the other members of your squad and the platoon leader. The icon with the X is the platoon leader. The icon with the 1 is the squad leader. Alpha Team is shown by 1A. Bravo Team by 1B.

The clock is moving.

Chat

Input

Everybody -- in the lower box of the chat window type Guidons, radio check, over.

Use the button at the bottom of the window to send your message to the other members of your squad.

Squad Leader -- use the SquadNet button to send messages to the Team Leaders. Use the PlatoonNet button to send messages to the Platoon Leader.

Can you see the messages from the other two guys? Can you tell who sent which message?

Everybody -- send a reply using standard radio procedures. Roger, over.

Got it? That's really all there is to using the chat window.

Chat cut and paste

Squad Leader -- You will be receiving messages from the Platoon Leader or Allied Command. These messages will come in on the Platoon Net. The Team Leaders do not have access to the Platoon Net.

What this means is that if you want to forward information from the Platoon Leader to the Team Leaders you can use copy and paste. Copy from the upper window, paste into the lower window, add whatever you want to add - like operational orders - and send your message using the SquadNet.

For example, here is a message from the Platoon Leader that you might want to forward to the Team Leaders after you add operational orders.

PL:

SIGINT indicates IED cell activity south of the mosque. Commence cordon and search.

Practice the copy and paste. Don't worry about the operational orders yet.

Team Leaders -- did you get the communication about the SIGINT?

Chat or Huddle

During the experiment we want you to communicate using the chat window ONLY. No yelling, no passing notes. There is one exception. The Squad Leader can call a 'huddle' where the three of you gather together to 'draw in the sand' etc.

Team Leaders: Your icons need to be in adjacent cells before you can get out of your chairs and walk over the Squad Leader.

Digital Chem Lights

The chem. lights are represented by colored dots.

Team Leader BOI:
Everyone -- Select a yellow chem. light. Click somewhere in the big palm grove.

Can you see three chem. lights?

Change the color of the light you placed on the map by selecting a different color dot in the palette and placing it on top of the old one. Use the 'none' color to erase your chem. light.

Squad Leader BOI:
Squad Leader -- Select a yellow chem. light. Click somewhere in the big palm grove. Change the color of the light you placed on the map by selecting a different color dot in the palette and placing it on top of the old one. Use the 'none' color to erase your chem. light.

Remember - the Team Leaders cannot see chem. lights.

Moving your icon

Moving your icon on the map takes two steps. First you select it using the Unit Palette. Then you select a cell on the map that marks your intended location - where you will move to.

The first step is to click on the icon in the Unit Palette. This often takes two clicks, first on the icon followed by a click on the first letter of the icon name. What you want is for the icon to light up. As soon as it lights up, the system knows you intend to move your icon on the map.

Try it. Select your icon in the unit palette. Make it light up.

The second step is to click on the cell in the map where you want to move to. I suggest you all move three or four cells west.

Do it again. Move several cells north. Remember to start by making the icon in the Icon Palette light up.

Got it?

Now you can move and chat. Time to practice a mission.

Squad move #1

PL puts blue light 26 20

PL:

1st Squad Move from current location to the blue chem light.

Team Leader BOI:
Team Leaders -- Wait for your orders and get ready to move out.

Squad Leader -- the Team Leaders can see the blue chem. light. Use the chat window to direct your squad. Have Alpha Team take the lead. Your mission.

Squad Leader BOI:
Team Leaders -- Wait for your orders and get ready to move out.

Squad Leader -- the Team Leaders CANNOT see the blue chem. light. Use the chat window to direct your squad. Have Alpha Team take the lead. Your mission.

Squad move #2

Let's practice that again. Same drill, different chem. light.

PL puts yellow light 28 26

PL:

1st Squad Move from current location to the yellow chem light

Squad Leader -- Your mission.

About Houses and Roads

You need to know that the system is programmed to take you in as direct a line as possible from your starting point to your intended position. If there is a house in the direct path, you will move through it. Trying to move through a house is not a good idea. It takes a long time. If there is a house between you and your destination, it is probably a good idea to go around using several short segments. Complete one segment before starting another. A straight line is not necessarily the fastest path.

You can move fast down some of the main roads. The main roads are great for covering ground quickly. However, the bad guys have been known to put IEDs on the main roads.

Bottom line: choose your routes carefully.

Squad move #3

PL puts blue light 35 37

PL:

1st Squad Move from current location to establish a squad blocking position at blue chem light

Team Leader BOI:
Squad Leader -- the Team Leaders can see chem. lights that you put on the map. Use the yellow chem. light to show the path. Use the chat window to issue your orders.

Squad Leader BOI:
Squad Leader -- the Team Leaders CANNOT see the blue chem. light. Use the chat window to issue your orders.

Insurgents

Unhappy face 41 37

Insurgents show themselves in mosque courtyard.

When noticed,

This is what an insurgent looks like. (red unhappy face) When you are around, they tend to stay undercover. If you can see one, you can assume he has hostile intentions. All insurgents are well armed and are willing to die.

This is what they look like after you have killed them (green smiley face).

Ammo

To the Team Leader who has depleted ammo. How much ammo have you got now? (32-45 usually). You started with 60. You spend N 'rounds' to take care of the insurgents.

Squad Leader: How much ammo have you got? (10). You have 10 because you are 1 guy. They have 60 because they are 4, 1 has a SAW. Squad Leader - if you take on an insurgent alone, you are likely to die. The implication is that it might be wise to have a Team take the lead.

Questions ?

Etiquette at the end of a session

A session ends when time runs out OR you achieve your mission, whichever happens first.

DO NOT click on the red X, ever. When the session ends, wait for me to shut the system down.

<Stop manager … Exit>

I have shut the system down. What you see now are the Marines on Iwo Jima, a white Applet screen, and a black system screen.

Click on the X in the upper right corner of the black screen.

Asking for help

If you have trouble with the interface, get our attention. We will help you.

If you mess up on your mission, you can ask for assistance.

If you get completely bogged down, one of us might make a suggestion.

Questions?

Questions?

Time to stretch. The briefing will start in 5 minutes.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX 5. TACTICAL BRIEF

Background

Seven years after the American invasion of Iraq, the country remains mired in a new round of political turmoil following in the wake of indecisive parliamentary elections. The initial results of the March 7 vote showed the coalition led by a secular candidate, Allawi, taking a slim lead over the slate of Prime Minister al-Maliki, with 91 seats to 89. Mr. Allawi, although a Shiite, benefited from a surge in voting by Sunnis, many of whom boycotted earlier elections.

Mr. Maliki vigorously challenged the results, but Mr. Allawi's narrow lead survived a recount. Mr. Maliki also forged an alliance between his coalition and the other major Shiite bloc, a move that cleared the way for a Shiite-dominated government for the next four years. Together they are only four votes short of a majority, leading many to expect that they might reach a deal with Kurdish parties, once the Kurds extract new promises of expanded autonomy. That would recreate the coalition that ruled for the last four years, and could leave Sunnis feeling left out in the cold once again.

The political impasse has disgusted many ordinary Iraqis, who are deeply cynical about their political class. The decision of the Shiite parties to band together has revived sectarian tensions that are never far from the surface and has raised the specter of even more violence.

While the level of violence has plunged from the carnage of 2006 and 2007, suicide bombers continue to attack, seemingly at will, plunging Baghdad into chaos on a regular basis and undercutting Mr. Maliki's claims to have restored security. IED attacks along the major roadways bisecting or adjacent sectarian enclaves are also becoming more frequent and are designed to disrupt commerce, the tactical mobility of Iraqi and Coalition forces, and further discredit the Maliki government’s claims of restored security throughout the country. Mr. Maliki's use of the military and security forces to settle political disputes have also raised alarms, and put the Americans in the awkward middle. Political disputes between Arabs and Kurds in the north also continue to fester. With no sign of a resolution in sight for ordinary Iraqis who are the continuous victims of this myriad of frictions, increasing violence and civilian death tolls have prompted Coalition Forces to once again take a more active role to intervene.

Your battalion is headquartered at CAMP TAJI. A very active IED Cell has emerged to the east of Taji; operating with virtual impunity along MSR 2 over the last four months. Data and information collected from multi-source intelligence assets has led the S2 to conclude that the cell has established at least three safe haven areas near where the majority of the IED events have occurred. The areas are labeled OBJs Orlando, Tampa, and Miami. As a result, the battalion has designated AO Lion and reestablished two company sized COPs within the area to facilitate continuous operations designed to find and destroy the cell leaders and production facilities. Your company occupies COP

UTAH located south of OBJ Miami. The company employs two platoons and the scouts in continuous reconnaissance patrolling and counter-IED ambushes, while maintaining a platoon TST element. Your platoon has been actively patrolling in the area for at least the last 2 weeks along with 3rd PLT and the Scouts. 48 hours ago, your platoon became the TST unit and expects to rotate back to patrolling after 7 days.

Situation

A counter-IED ambush succeeded in spotting an IED emplacement element at work earlier today and cued a RAVEN UAV in order to follow the team back to their safe house. A squad patrolling in the area from 3rd platoon was vectored onto the IED team and succeeded in capturing them before they could ditch or destroy their cell phones. The numbers captured from the cells have provided a selector for the IED cell leader who has yet to discover the compromise and failed to hit his timed OPSEC schedule to switch phones. SIGINT has pinpointed the selector at GRID 40 38 within OBJ MIAMI. Your platoon has received the TST raid mission to kill or capture the IED cell leader.

Mission

1st PLT attacks seize OBJ BOMBER vic GRID 40 38 NLT DTG in order to kill or capture IED cell leader and prevent further attacks along MSR2.

Concept of the operation

The platoon executes a cordon and search conducted in three phases: approach, establishment of the cordon, and assault /search. The cordon forces will consist of both Stryker Sections (outer cordon) and 1st and 2nd Squads (inner cordon). The assault force is 3rd squad.

Scheme of maneuver

Phase I (Approach)

Platoon approaches the identified objective area mounted along ROUTE GOLD to a dismount point vic GRID 35 12. The Stryker Sections herring bone at the dismount point and squads form a hasty security perimeter with Red at 7 o'clock, White at 2 o'clock, and Blue at 11 o'clock. The dismount point is the squad level release point for continued movement by squad infiltration into the target objective area. On order, squads continue dismounted - Red infiltrates along AXIS CAT, White along AXIS GERBIL, and Blue along AXIS DOG

Phase II (Establishment of the Cordon)

RED1 occupies BLOCKING POS marked with BLUE CHEMLITE vic GRID 35 47 in order to isolate OBJ BOMBER and prevent escape to the N and NW. WHITE1 move to and occupy BLOCKING POS marked with BLUE CHEMLITE vic GRID 55 41 in order to isolate OBJ BOMBER and prevent escape to the E and NE. RAVEN7 maintains

section at original DISMOUNT PT in order to prevent reinforcement from the south and expedite evacuation of the objective area. BLUE1 move to and seize ASLT POS vic GRID 34 30 marked with BLUE CHEMLITE in order synchronize cordon with ASLT on target.

Phase III (Assault/Search)

On order, ATK to seize OBJ BOMBER2 in order to kill or capture TGT (Hamadi). RED1, WHITE1, BLUE1 be prepared to exfil to original DISMOUNT PT or alternate LINKUP PT after BLUE1 reports BOMBER2 clear and TGT (Hamadi) secured. On order all squads exfil to original DISMOUNT PT or designated LINKUP PT to remount and return to COP UTAH. RAVEN7 be prepared to move to LINKUP PT marked with YELLOW CHEMLITE vic GRID 48 33 as an alternate to original DISMOUNT PT to remount squads or establish PLT CCP as needed.

Service support

Ammo: Full Basic Load
Individual Load: Assault Rucks only. Water = 6 Hours. Batteries = 6 Hours
PLT CCP: GRID 48 33
SIGINT: Friendly forces will continue to monitor the identified selector
UAV: Continuous RAVEN UAV coverage during the operation.

Command and signal

Succession = PL, BLUE 1, PSG.
PL & RTO with BLUE throughout.
CHAT feature equals FM comms.

SLANT = STRYKER/PAX/AMMO/MEDICAL

AMMO:
Green > 70% IBL on hand
Amber > 40% IBL on hand
Red > 20% IBL on hand
Black < 20% IBL on hand

MEDICAL:
Green = No mission impact injuries or casualties
Amber = Injury or casualties impact, but don't prevent mission accomplishment
Red = Injuries of casualties prevent mission accomplishment

CALL SIGNS:
PL = RAVEN6
PSG = RAVEN7
1SL = RED1

A TL 1SQD =	RED2
B TL 1SQD =	RED3
2SL =	WHITE1
A TL 2SQD =	WHITE2
B TL 2SQD =	WHITE3
3SL =	BLUE1
A TL 3SQD =	BLUE2
B TL 3SQD =	BLUE3

APPENDIX 6. SCRIPT FOR MISSION 1 (BLUE SQUAD) – ASSAULT ON SAFE HOUSE

MISSION 1 .. Assault on safe house

Immediately, Organize at the Dismount Point

Red light 40 38

Blue light 35 47
Blue light 34 30
Blue light 55 41

PL:
Guidons, this is RAVEN6. SITREP over.

1st Squad:
RAVEN6 this is RED1. SLANT 9/Green/Green. |Prepared to move on AXIS CAT, over.

PL:
Roger RED1, stand by.

2SQD:
RAVEN6 this is WHITE1. SLANT 9/Green/Green. |Prepared to move AXIS GERBIL, over.

PL:
Roger WHITE1, stand by.

(3SQD: RAVEN6 this is BLUE1. SLANT 9/Green/Green. Prepared to move AXIS DOG over.)

PL:
Roger BLUE1, stand by.

PL:
Guidons move out, |RAVEN follows BLUE element, over.

1SQD:

This is RED1, WILCO, out.

2SQD:
This is WHITE1, WILCO, out.

(3SQD: This is BLUE1, WILCO, out.)

Squads move to positions.

Move RED and WHITE and PL units

When there …

<u>When Squad 3 Blue gets to the Assault Position</u>
(3SQD: RAVEN6 this is BLUE1. |Set in ASLT POS with negative contact. |Eyes on OBJ. No activity noted. |SLANT 9/Green/Green, over.)

PL:
BLUE1 this is RAVEN6, Roger, out.

<u>When Squad 1 Red gets to the NW Blocking Position</u>
1SQD:
RAVEN6 this is RED1. |Set in BLOCKING POS with negative contact. |SLANT 9/Green/Green, over.

PL:
RED1 this is RAVEN6, Roger, out.

When Squad 2 White gets to the NE Blocking Position
2SQD:
RAVEN6 this is White1. |Set in BLOCKING POS with negative contact. |SLANT 9/Green/Green, over.

PL:
WHITE1 this is RAVEN6, Roger, out.

When all Squads in Place … Scenario 1, Blue Assault

PL:
GUIDONS this is RAVEN6. EXECUTE when ready, over.

1SQD:
This is RED1, Roger, out.

2SQD:
This is WHITE1, Roger, out.

(3SQD: This is BLUE1, EXECUTING ASLT time now, out.)

When all Insurgents are dead

Blue light 46 32

PL:
Guidons this is Raven 6.|Mission complete - all targets have been killed or captured. |Move to Link UP VIC 46 32 marked with blue chem lite and await further orders.

1SQD:
This is RED1, Roger, out.

2SQD:
This is WHITE1, Roger, out.

(3SQD: This is BLUE1, Roger, out.)

END

Time to stretch. The experiment will start in 5 minutes.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX 7. SCRIPT FOR MISSION 2 (RED SQUAD) – CORDON AND ADJUST TACTICAL POSITION

MISSION 2 .. Northwest cordon and Adjust position

Immediately, Organize at the Dismount Point

Red light 40 38

Blue light 35 47
Blue light 34 30
Blue light 55 41

PL:
Guidons, this is RAVEN6. SITREP over.

(1st Squad: RAVEN6 this is RED1. |SLANT 9/Green/Green. |Prepared to move on AXIS CAT, over.)

PL:
Roger RED1, stand by.

2SQD:
RAVEN6 this is WHITE1. |SLANT 9/Green/Green. |Prepared to move AXIS GERBIL, over.

PL:
Roger WHITE1, stand by.

3SQD:
RAVEN6 this is BLUE1. |SLANT 9/Green/Green. |Prepared to move AXIS DoG, over.

PL:
Roger BLUE1,

PL:
Guidons move out. |RAVEN follows BLUE element, over.

(1SQD: This is RED1, WILCO, out.)

2SQD:
This is WHITE1, WILCO, out.

3SQD:
This is BLUE1, WILCO, out.

Squads move to positions.

Move WHITE and BLUE and PL units.

When there …

When Squad 3 Blue gets to the Assault Position
3SQD:
RAVEN6 this is BLUE1. |Set in ASLT POS with negative contact. |Eyes on OBJ. No activity noted. |SLANT 9/Green/Green, over.

PL:
BLUE1 this is RAVEN6, Roger, out.

When Squad 2 White gets to the NE Blocking Position
2SQD:
RAVEN6 this is White1. |Set in BLOCKING POS with negative contact. |SLANT 9/Green/Green, over.

PL:
WHITE1 this is RAVEN6, Roger, out.

When Squad 1 Red gets to the NW Blocking Position
(1SQD: RAVEN6 this is RED1. |Set in BLOCKING POS with negative contact. |SLANT 9/Green/Green, over.)

PL:
RED1 this is RAVEN6, Roger, out.

When all Squads in Place … Red FRAGO

PL:
Guidons this is RAVEN6. |MUSTANG6 reports target (Hamadi) has moved NE to new location. |I say again, MUSTANG6 reports target has moved to new location. |Stand by for FRAGO, over.

(1SQD: This is RED1, WILCO, over.)

2SQD:
This is WHITE1, WILCO, over.

3SQD:
This is BLUE1, WILCO, over.

PL: Red chem. light 64 47
PL: 3 Blue chem. lights 54 52 78 46 65 36
PL: Yellow chem. light 55 45

PL:
Guidons this is RAVEN6. FRAGO follows. Selector indicates target has moved NE to GRID 64 47 OBJ BOMBER2; marked with RED CHEMLITE. |On order RED1 move to and occupy BLOCKING POS marked with BLUE CHEMLITE vic GRID 54 52 to isolate OBJ BOMBER2 and prevent escape to the N and NW. |WHITE1 move to and occupy BLOCKING POS marked with BLUE CHEMLITE vic GRID 78 46 to isolate OBJ BOMBER2 and prevent escape to the E and NE. |RAVEN7 maintain current cordon to the S and SE. Be prepared to move to LINKUP PT marked with YELLOW CHEMLITE vic GRID 55 45 as an alternate to original DISMOUNT PT in order to expedite evacuation of the objective area. |BLUE1 move to and seize ASLT POS vic GRID 65 36 marked with BLUE CHEMLITE to synchronize cordon with ASLT on target. |On order, ATK to seize OBJ BOMBER2 in order to kill or capture TGT (Hamadi). |RED1, WHITE1, BLUE1 be prepared to exfil to original DISMOUNT PT or alternate LINKUP PT after BLUE1 reports BOMBER2 clear and TGT (Hamadi) secured. |All elements report when prepared to move. |Movement to OBJ BOMBER2 begins on my order. |Report when set in BLOCKING and ASLT POS. Initiate assault on my order. Acknowledge over.

(1SQD: This is RED1, roger, over.)

2SQD:
This is WHITE1, roger, over.

3SQD:
This is BLUE1, roger, over.

Shortly Thereafter …

2SQD:
RAVEN6 this is WHITE1. SLANT 9/Green/Green. Prepared to move, over.

PL:
Roger WHITE1, stand by.

3SQD:
RAVEN6 this is BLUE1. SLANT 9/Green/Green. Prepared to move, over.

PL:
Roger BLUE1, stand by.

(1SQD: RAVEN6 this is RED1. SLANT 9/Green/Green. Prepared to move, over.)

PL:
Roger RED1, Guidons move out, RAVEN follows BLUE element, over.

(1SQD: This is RED1, WILCO, out.)

2SQD:
This is WHITE1, WILCO, out.

3SQD:
This is BLUE1, WILCO, out.

Squads Move to New Positions

Move RED and WHITE units

Eventually …

2SQD:
RAVEN6 this is WHITE 1. Set in BLOCKING POS with negative contact. |SLANT 9/Green/Green, over.

PL:
WHITE1 this is RAVEN6, Roger, out.

3SQD:
RAVEN6 this is BLUE1. Set in ASLT POS with negative contact. |Eyes on OBJ. No activity noted. |SLANT 9/Green/Green, over.

PL:
BLUE1 this is RAVEN6, Roger, out.

(1SQD: RAVEN6 this is RED1. Set in BLOCKING POS with negative contact. SLANT 9/Green/Green, over.)

PL:
RED1 this is RAVEN6, Roger.

Blue force conducts assault of Bomber2

PL:
Guidons this is RAVEN6. EXECUTE time now, over.

(1SQD: This is RED1, Roger, out.)

2SQD:
This is WHITE1, Roger, out.

3SQD:
This is BLUE1, EXECUTING ASLT time now, out.

When all Insurgents are dead

Blue light 46 32

PL:
Guidons this is Raven 6.|Mission complete - all targets have been killed or captured. |Move to Link Up point VIC 46,32 marked with blue chem lite and await further orders.

(1SQD: This is RED1, Roger, out.)

2SQD:
This is WHITE1, Roger, out.

3SQD:
This is BLUE1, Roger, out.

END

Time to stretch. The experiment will start in 5 minutes.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX 8. SCRIPT FOR MISSION 3 (WHITE SQUAD) – CORDON AND REINFORCE ENGAGED UNIT

MISSION 3 .. Northeast cordon and Support unit under fire

Immediately, Organize at the Dismount Point

Red light 40 38

Blue light 35 47
Blue light 34 30
Blue light 55 41

PL:
Guidons, this is RAVEN6. SITREP over.

1st Squad:
RAVEN6 this is RED1. SLANT 9/Green/Green. |Prepared to move on AXIS CAT, over.

PL:
Roger RED1, stand by.

(2SQD: RAVEN6 this is WHITE1. SLANT 9/Green/Green. Prepared to move AXIS GERBIL, over.)

PL:
Roger WHITE1, stand by.

3SQD:
RAVEN6 this is BLUE1. SLANT 9/Green/Green. |Prepared to move AXIS DOG, over.

PL:
Roger BLUE1,

PL:
Guidons move out. |RAVEN follows BLUE element, over.

1SQD:
This is RED1, WILCO, out.

2SQD: This is WHITE1, WILCO, out.

3SQD:
This is BLUE1, WILCO, out.

Squads move to positions.

Move RED and BLUE and PL units.

When there …

When Squad 3 Blue gets to the Assault Position
3SQD:
RAVEN6 this is BLUE1. |Set in ASLT POS with negative contact. |Eyes on OBJ. No activity noted. |SLANT 9/Green/Green, over.

PL:
BLUE1 this is RAVEN6, Roger, out.

When Squad 1 Red gets to the NW Blocking Position
1SQD:
RAVEN6 this is RED1. |Set in BLOCKING POS with negative contact. |SLANT 9/Green/Green, over.

PL:
RED1 this is RAVEN6, Roger, out.

When Squad 2 White gets to the NE Blocking Position
(2SQD: RAVEN6 this is White1. |Set in BLOCKING POS with negative contact. |SLANT 9/Green/Green, over.)

PL:
WHITE1 this is RAVEN6, Roger, out.

When all Squads in Place … White FRAGO … Support Unit under Fire

Insurgent: Icon at 41 38

3SQD:
RAVEN6 this is BLUE1, Contact GRID 41 38 SITREP to follow over.

PL:

This is RAVEN6, roger over.

3SQD:
RAVEN6 this is BLUE1, Contact GRID 41 38 |4-5 man element with AK47s continues to engage Bravo Team with effective fire from TGT location. |Bravo has two wounded - one routine and one priority. Unable to disengage. |Alpha continues to suppress, but cannot gain fire superiority at this time. |We are unable to determine if Hamadi remains in the Target location, |SLANT 9/Green/Amber, over.

PL:
This is RAVEN6, roger, stand by, over.

Pause for FRAGO

PL: Blue chem. light 42 33
PL: Yellow chem. light 48 33

PL:
Guidons this is RAVEN6. FRAGO follows. |RED1 remain in BLOCKING POS to isolate OBJ BOMBER |and prevent escape to the N and NW or reinforcement from the N. |WHITE1 move to and occupy ATTACK BY FIRE POS marked with BLUE CHEMLITE vic GRID 42 33 |to allow BLUE3 (BRAVO TM) to disengage and evacuate casualties. |Initiate movement ASAP. Report when moving and when set. |RAVEN7 be prepared to move to LINKUP PT marked with YELLOW CHEMLITE vic GRID 48 33 |to establish CCP and expedite possible evacuation of the objective area. |BLUE1 continue to engage from current locations in order to protect BLUE3. |Be prepared to evacuate casualties to CCP vic GRID 48 33. |I will link up with White1 in ABF POS when established. |Acknowledge over.

1SQD:
This is RED1, roger, over.

(2SQD: This is WHITE1, roger move to ABF GRID 42 33 over.)

3SQD:
This is BLUE1, roger, over.

Shortly Thereafter …

(2SQD: RAVEN6 this is WHITE1. SLANT 9/Green/Green. Moving time now, over.)

PL:
RAVEN6, Roger, over.

White Squad Moves to New Position

Once There …
(2SQD: RAVEN6 this is WHITE 1. Set in ABF POS. Engaging TGT location. SLANT 9/Green/Green, over.)

PL:
WHITE1 this is RAVEN6, Roger, moving to your location time now, out.

Move PL to 42 33

PL:
Blue hold and estab SBF. White enter building at SE corner, over

When all Insurgents are dead

Yellow light 46 32

PL:
Guidons this is Raven 6.|Mission complete - all targets have been killed or captured. |Move to CCP VIC 46 32 marked with yellow chem lite and await further orders.

1SQD:
This is RED1, Roger, out.

(2SQD: This is WHITE1, Roger, out.)

3SQD
This is BLUE1, Roger, out.

END

That is the end of the experiment gentlemen. Thank you for your cooperation and expertise.

LIST OF REFERENCES

Brehmer, B. (2005). Micro-worlds and the circular relation between people and their environment. *Theoretical Issues in Ergonomics Science*, *6*(1), 73-93.

Brehmer, B., & Dörner, D. (1993). Experiments with computer-simulated microworlds: Escaping both the narrow straits of the laboratory and the deep blue sea of the field study. *Computers in Human Behavior*, *9*(2-3), 171.

Colebank, J. L. (2008). Automated intelligent agents: Are they trusted members of military teams? MS Thesis in Human Systems Integration. Monterey, CA: Naval Postgraduate School.

Granlund, R. (2003). Monitoring experiences from command and control research with the C3Fire microworld. *Cognition, Technology & Work*, *5*(3), 183-190.

Evangelista, P. (2009). Representing networking enabled soldiers in military models and simulations. Briefing to TRAC Monterey. Monterey, CA: Naval Postgraduate School.

Hernandez, R. M., Ray, K., Papadapoulas, S., & Glaser, W. (2010). Effects of ground soldier system (GSS) on coordinated navigation of squad level teams. Class project for OA4408, Team Performance, Winter 2010. Monterey, CA: Naval Postgraduate School.

Johansson, B., Persson, M., Granlund, R., & Mattsson, P. (2003). C3Fire in command and control research. *Cognition, Technology & Work*, *5*(3), 191-196.

Lindgren, I., & Smith, K. (2006a). Using microworlds to understand cultural influences on distributed collaborative decision making in C2 settings. *Proceedings of the 11th Annual International Command and Control Research and Technology Symposium (ICCRTS)*. Cambridge, UK. Winner Best Student Paper Award.

Lindgren, I., & Smith, K. (2006b). National patterns of teamwork during an emergency management simulation. *Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting*. San Francisco, CA, 354-357.

Lindgren, I., Smith, K., & Granlund, R. (2007). Predicting group faultlines in multicultural C2 operations. *Proceedings of the 12th International Command and Control Research and Technology Symposium (ICCRTS)*. Newport, RI.

Rigas, G., Carling, E., & Brehmer, B. (2002). Reliability and validity of performance measures in microworlds. *Intelligence*, 30, 463-480.

Smith, K. (2008). Empirical studies and an explanatory model of cultural differences in goal setting, task allocation, and communication. *Proceedings of the NATO HFM-142 Symposium on Adaptability in Coalition Teamwork*. Copenhagen, Denmark.

Smith, K., Lindgren, I., & Granlund, R. (2006). Empirical studies of cultural barriers to collaborative decision making in international emergency services operations. *Proceedings of the 18th International Conference of the International Association for Cross-Cultural Psychology*. Spetses, Greece, 54-55.

Smith, K., Lindgren, I., & Granlund, R. (2010). Etiquette to bridge cultural faultlines. In C. Hayes and C. Miller (Eds.), *Human-computer etiquette: Understanding the impact of human culture and expectations on the use and effectiveness of computers and technology*. Boca Raton, FL: Taylor and Francis Group.

Thomas, J. A. (2005). Evaluating the claims of network centric warfare. MS Thesis in Human Systems Integration. Monterey, CA: Naval Postgraduate School.

INITIAL DISTRIBUTION LIST

1. Research Office (Code 09).....1
   Naval Postgraduate School
   Monterey, CA 93943-5000

2. Dudley Knox Library (Code 013).....2
   Naval Postgraduate School
   Monterey, CA 93943-5002

3. Defense Technical Information Center.....2
   8725 John J. Kingman Rd., STE 0944
   Ft. Belvoir, VA 22060-6218

4. Richard Mastowski (Technical Editor).....2
   Graduate School of Operational and Information Sciences (GSOIS)
   Naval Postgraduate School
   Monterey, CA 93943-5219

5. LTC David Hudak, USA.....1
   TRAC Monterey
   Naval Postgraduate School
   Monterey, CA 93943

6. MAJ Paul Evangelista, USA.....2
   TRAC Monterey
   Naval Postgraduate School
   Monterey, CA 93943

7. Professor Kip Smith.....2
   Operations Research Department
   Naval Postgraduate School
   Monterey, CA 93943

8. Professor Robert F. Dell 1
   Operations Research Department
   Naval Postgraduate School
   Monterey, CA 93943

9. Professor Larry Shattuck.....1
   Operations Research Department
   Naval Postgraduate School
   Monterey, CA 93943

10. COL James Riley, USA (Ret.).....electronic copy